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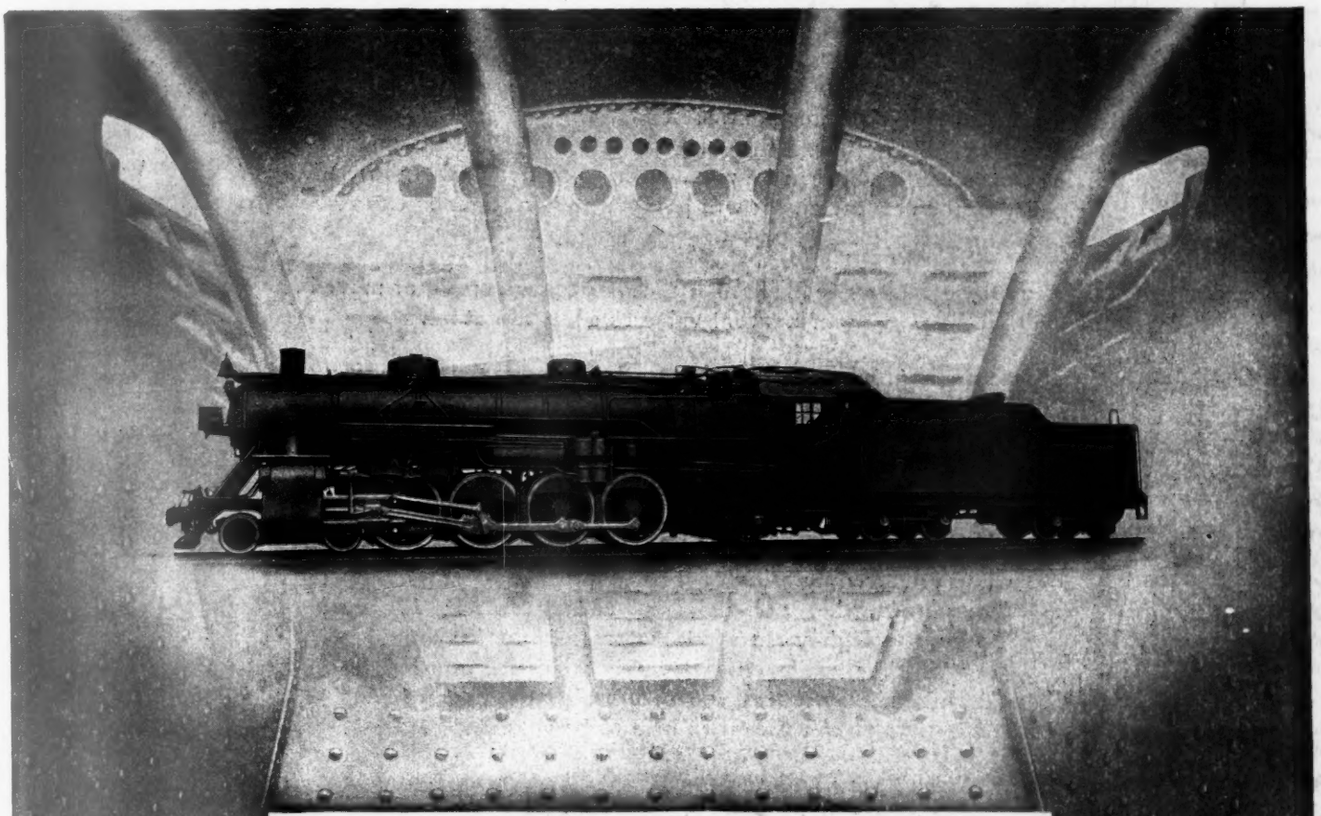

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Volume 95 | February, 1921 | No. 2

CONTENTS

EDITORIALS:

A Difficult Problem 69
What Are the Real Remedies? 69
Sharp Tire Flanges 70
Next Step in Welding Development 70
Maintain Locomotive Valve Gears 70
Turret Lathe Practice 71
For a Sound Knowledge of Heat Treating 71

COMMUNICATIONS:

Pencil Repairs and Inexperienced Foremen 71
Assigning Engines 71
New Books 72

GENERAL:

Modernizing Existing Locomotive Terminals 73
Grease Lubrication 76
Locomotives and Cars Ordered and Built in 1920 77
Car and Locomotive Prices Reached Peak in 1920 80
Three Column Frame Milling Machine 83
Increasing the Capacity of Old Locomotives 84
The Care of Locomotive Boilers 87
Reducing the Fuel Consumption of Power Plants 88
Labor Board Opens Hearings on Working Conditions 92
Questions and Answers 93

CAR DEPARTMENT:

Sulphuric Acid Tank Cars of 70 Tons Capacity 94
Cause of the Present Condition of Freight Cars 97
New Plans and Specifications for Postal Cars and Fixtures 101
A Blue Print Bath 101
The Futrell Automatic Train Line Connector 102
Journal Packing Reclamation 104
The Use of Wood in Freight-Car Construction 105
Shop Safety Gate 106
Designing Brake Heads for Uniform Shoe Wear 107

SHOP PRACTICE:

Cylindrical Grinding in 1920 109
Railroad Shop Turret Lathe Practice 111
The Reason Why Some Fusion Welds Fail 114
Staybolt and Stud Driver and Remover 118
High Pressure Pump for Air Test Rack 118
Truck for Handling Jacket Iron 118
An English Locomotive Repair System 119
Closing Triple Valve Piston Ring Grooves 122
A Short Cut in Squaring Locomotive Valves 123
Paint Spraying Locomotive Front Ends 124

NEW DEVICES:

Single Pedestal Swivel Type Car Seat 125
Heavy Duty Motor Driven Face Grinder 126
Tube Safe End with Square Shoulder 127
Two-Unit Feeding Device for Shapers 128
Thirty-Inch Shoe and Wedge Planer 129
Angle Plate with Second Face and T-Slot 129
Bolster Attachments for Metal Draft Arm 130
Compact Selective Head Engine Lathe 131
New Drive for Heavy Duty Radial Drill 132
Portable Electric Drill with Automatic Switch 132
A Scale-Proof Locomotive Crane Boiler 133
Redesigned Carbon Dioxide Recorders 133
Motor Drive for Milling Machines 134
Wood Turning Lathe of Unusual Length 134
Compact Portable Air Compressor Units 135
Efficient Rotary Piston Type Pump 135
Baker Boring and Drilling Machine 136

GENERAL NEWS:

Notes 137
Meetings and Conventions 138
Personal Mention 138
Supply Trade Notes 139
Trade Publications 142

A Difficult Problem

The statement made by J. C. Fritts, master car builder of the Delaware, Lackawanna & Western in a paper before the January meeting of the Western Railway Club, that a very large part of the present bad order equipment can be confined to approximately 400,000 cars is a fact which should be kept clearly in mind in considering the present unsatisfactory car conditions. The real problem may be even more sharply defined. Probably not less than three-quarters of these 400,000 cars are 30-ton and 40-ton box cars, with weak draft sills and ends, which are in circulation all over the country when the demand for cars is great. How can the extravagant maintenance expenditures, the constant delays to traffic and the constant risk and frequent damage to which the lading in these cars is subjected be eliminated? When cars are in demand there is little opportunity to improve the condition of this equipment. At such times much of it is on foreign lines and the frequent sojourns on the repair track at best result only in repairs in kind, which are not of constructive value. When away from home the only constructive measure possible is the retirement and dismantling of these cars under Rule 120. But it is evident that owners are refusing to authorize extensive retirements under this rule, and it is probable that until confidence is restored in the stability of equipment prices most of these old cars may be expected to remain in service. How, then, are they to be made fit for service? Evidently this can only be done by the owning road and the opportunity for rehabilitation is offered the owning roads only when there is a surplus of cars such as has been created by the present business recession. It is unfortunate that the opportunity is only offered at a time when the railroads are financially unable to take full advantage of it, and for that reason the results of every hour's labor that is expended should be made to produce the utmost return by thoroughly overhauling a few cars and not attempting to turn out as many cars as possible with the least amount of work per car. Only in this way may any improvement in the condition of freight cars be expected.

What Are the Real Remedies?

A careful consideration of the present unsatisfactory condition of freight cars does not suggest the possibility of finding a remedy the application of which may be expected to effect an immediate cure. The malady long ago became chronic and the symptoms are now only a little more acute than usual. No permanent improvement can be expected until the deep-seated causes are located and removed. The present conditions are due in a very large measure to the failure of each railroad to give to all cars "equal care as to inspection and repairs, regardless of responsibility for expenses of repairs." There are two principal reasons for this failure. The first is the inability of the roads to make thorough repairs in kind to cars differing from their own standards without excessive delays, and the inability under the rules to apply betterments to other than their own cars. The second reason

for this failure is the lack of any incentive for the individual road to do more than the minimum amount of work necessary to get the foreign car off its line as more than this amount of work is of no direct benefit to itself. Two possibilities suggest themselves for removing the first difficulty; either a change in the rules removing some of the limitations on foreign car repairs, or the development of a more complete program of standard and interchangeable details. The first is obviously unfair to the car owners until the latter has been developed and it is improbable that any accomplishment will be obtained in either direction, except as the result of a long period of slow and painful effort. There is only one way to overcome the second great cause for the chronic state of dilapidation of freight cars and that is to provide the now lacking incentive. In the commercial and industrial world the one incentive which produces activity is the hope or prospect of profit. Railroad corporations are no different in their nature than those in other fields, and the prospect of profit on any transaction is the only incentive likely to cause whole-hearted performance. The suggestion that prices for labor and material be set high enough to show a profit above the cost of labor and material plus the overhead, offers a means of supplying this incentive. The effect of such an incentive would probably be less manifest in the amount of repairs to foreign cars than in the greater efforts by owning roads to keep their own cars in the best possible condition, in order to avoid as much as possible the payment of the high repair bills. The most beneficial effect immediately following the adoption of such a plan would probably be the retirement or complete rehabilitation of the large number of cars now in service which long since ceased to be economical carrying units. What disadvantage to such a plan can offset its value as a potent force to raise the standard of freight car maintenance?

Sharp Tire Flanges

"An ounce of prevention is worth a pound of cure" and the old saying was never more true than when applied to the malady commonly known as sharp flanges. Locomotives credited with only 20,000 or 30,000 miles keep coming again and again to repair shops with flanges worn thin on the front driving wheels. The prevention of this excessive cutting action would save the railroads thousands of dollars annually. With the long wheel base of a modern locomotive, it is practically impossible to eliminate excessive side pressure on the front driving wheel flanges, especially when rounding sharp curves. Provision for additional side play on the front wheels and in some cases setting the tires slightly nearer together helps, but by no means solves the problem. Cutting action continues, front flanges are worn to the limit of thickness, and there is a resultant serious loss of revenue while locomotives are held out of service waiting for and receiving necessary repairs.

When flanges become sharp after only a few months service, the machinery is usually in good condition and repair work on the locomotive consists of dropping the front wheels, removing the tires, applying and turning another pair and replacing them under the locomotive. In case second-hand tires, which will turn down to the required diameter, are not available, it is necessary to apply a pair of new tires and turn them, in an extreme case, from three and one-half down to two inches thick, with a resultant waste of material. In addition, the entire shop schedule is disarranged by injecting this light repair work, especially if the wheel department is already working to capacity.

It is not overstating the case to say that the problem of sharp flanges can be greatly simplified if not solved by the application and proper maintenance of some form of automatic flange lubricator, of which several are on the market. These lubricators have demonstrated their ability to reduce flange wear and cutting action to a minimum and indirectly increase the life of rails on curves and locomotive mileage. Flange lubricators are for the most part simple and automatic in action, requiring little attention, but without this little attention they become absolutely valueless for the purpose intended. If examined at least once each trip to make sure that they are not clogged with dirt or caught in such a way as to be rendered inoperative, automatic flange lubricators will go far toward solving the problem of sharp flanges.

Next Step in Welding Development

It is natural that the early stages of the development of an art such as fusion welding should be devoted exclusively to the technique of the process itself. The process has continually been put to new uses with little thought beyond questions of manipulation, the controlling factor being the convenience with which the work may be done and the large saving to be effected in material. It is not surprising that in some cases the results of the application of the process have raised serious questions in the minds of railroad officers as to the safety of the use of the process on some classes of work already well within the field of application. Cases have occurred where the employment of fusion welding to fill out tires with flat spots, heat treated parts or pieces forged too small to finish, has apparently led to failures. The only satisfactory answer to the questions raised by such instances is one founded on knowledge and not on unsupported theory. Investigations such as that made by the Chicago, Rock Island & Pacific, described elsewhere in this issue, are of the utmost value, and strongly indicate that at present there is more need for attention to the effect of the welding operations on the metals worked on than to refinements in the technique of the operations themselves. General investigation in this phase of the subject will do much to direct intelligently the future extensions in the application of the art, and by avoiding some of the pitfalls such as have already been encountered, prevent the placing of reactionary limitations on the great possibilities for economy yet unattained.

Maintain Locomotive Valve Gears

No doubt exists as to the important part played by valve gears in locomotive operation. Ease of handling, quick response of a locomotive to its throttle and economical fuel consumption all depend upon an efficient valve gear, properly maintained. Valves must be square, with leads and cut-offs adjusted to predetermined standards, or the fuel wasted in the course of a few months or a year will amount to many tons for each locomotive. Designers of the several valve gears now on the market have bent every effort to perfect them, but this is of no avail unless they are maintained so as to make efficient locomotives. In far too many cases, the irregular exhausts of passing locomotives show at once that their valves are not square, caused by careless work in the back shops or lack of attention at roundhouses. In either case, the fault should be remedied to allow railroads to profit by the resultant increased train acceleration and decreased fuel consumption. Ordinarily it takes about eight hours to set the valves on a heavy locomotive, but it is not safe to insist on an arbitrary length of time for this operation. An unexpected difficulty may often develop and delay the work two or three hours. The only safe way is to develop dependable valve setters and allow them time enough to overcome difficulties and do the job right. Valve setting is one of the last operations in repairing a locomotive and unfortunately there is a tendency to slight the work rather than delay a

locomotive in the shop. This is false economy. With the high price of coal, it is especially important that locomotive valve gears be properly set and maintained in the best possible operating condition.

Turret Lathe Practice

Somewhere between the automatic and single purpose turning machine lies the field of use for turret lathes, bounded by fairly distinct lines of demarcation and within which the turret lathe has no close competitor. For quantity production, the automatic affords great possibilities of increased output at less cost per piece, while for work involving a single turning operation the common lathe usually is best adapted. Between these two extremes, however, there is a range of work best performed on the turret lathe which thus becomes an important factor in machine shop operation. Turret lathes of American make are adapted for both bar and chucking work, the change from one to the other being made easily and quickly. By working the tools in the turret and carriage simultaneously, a large amount of time is saved and the arrangement of cutting tools and stops for work involving several operations eliminates resetting many tools, reduces measurements required and speeds up the work. Many railroad shops today should be equipped with additional turret lathes and provision made for the more effective use of those already installed. Methods of tooling are very important in any attempt to secure maximum production, and attention is called to an article in this issue, showing the tooling of turret lathes for machining several locomotive parts. The sequence of operations, methods of tooling and respective times are given and the article should be of particular value to those interested in machine shop production. Probably the greatest value of the *Railway Mechanical Engineer* to shop men lies in the opportunity it offers for comparing experiences and finding out what the other fellow is doing. It is suggested that the article referred to be carefully studied and information submitted regarding any methods of machining which, in the opinion of the reader, will turn out as good work in less time than those shown.

For a Sound Knowledge of Heat Treating

The need for the greatest care, based on accurate knowledge, in the heating of steel either for forging or hardening has been quite generally too little appreciated. The wide range of possibilities for the control of the physical properties of steel by skillful heat treatment which have only recently been opened up to industry, has brought into strong relief this general lack of accurate information on the subject. To the Chicago chapter of the American Society for Steel Treating belongs the credit for one of the first practical steps to overcome this handicap. A committee of the chapter composed of men engaged in the metal working industries of Chicago has prepared the texts for a course on forging and heat treatment of steel, with the co-operation of the Armour Institute of Technology and the Lewis Institute, and evening classes are now being organized at both of these institutions. These courses are the beginning of a movement which may rapidly accelerate the practical application of possibilities in all industries which so far have nowhere been fully realized unless perhaps in the automobile industry. Manifestly, such a course cannot take the place of practical experience. Experience in the shop alone, however, unsupplemented by laboratory research or the study of the results of such research, will never make a really skilled heat treater. In no other lines of work is so much of vital importance hidden from the operator as in those involving the heating of metal, and real advancement can only come when to practical skill is added a thorough knowledge of these hidden facts.

COMMUNICATIONS

Pencil Repairs and Inexperienced Foremen

MECHANICSVILLE, N. Y.

TO THE EDITOR:

I have read numerous letters in the *Railway Mechanical Engineer* about the mechanics in the motive power department not being efficient in their work. I disagree with some of these letters, for there is too much work done right at the foreman's desk on the reports of the inspectors and engineers with a well-sharpened lead pencil and not by the mechanic. No power can stand up under the workmanship of a little lead pencil.

It looks at times as though the superior officers would rather have the payroll look good at the end of the month than to keep the power out of the back shop, though engines cannot make any money in the shop. What is saved in one month on the payroll is taken out of one engine in one trip.

When an engine comes out of the shop, it is all painted up and the roundhouse foreman may think it does not need the wedges or the back ends keyed up for some three or four months. He may finally get around to have the wedges set up after the boxes are pounded to pieces and the old rod bushings that were taken out in the shop would sound better in the rod than the new ones. Hundreds of dollars are spent on the engine because of the roundhouse foreman who is trying to keep the engines from coming across the turntable to be inspected and the necessary work done to keep the power in shape.

This appeals to me as very poor management, not on the part of the master mechanic, but the supervisory forces under him. Just for the want of about three hours' work to reduce a back end or a front end the engine is allowed to go out and the next day it is towed in on account of a piston rod, crosshead or back end strap broken and then it is laid to poor workmanship on the part of the mechanical forces.

No foreman can bring power back to first-class shape that is ready for the shop but the new power out of the shops and from the locomotive works can be kept up and inside of eight or nine months you can see the vast difference in the number of engines that have been going to the back shop but are now in service on the road. The railroads of today need system and efficient work foremen, not a bunch of school kids to be foremen over a body of mechanics. The foremen of today ought to be in a position to direct the men, not have them directing him how a job had ought to be done along with the handling of his forces.

A. F. BARBOLT.

Assigning Engines

CHAPLEAU, Ont., Canada.

TO THE EDITOR:

In your issue of November I read over very carefully a communication by Geo. N. Clouser on assigning engines. I do not know whether Mr. Clouser has reference to some particular railroad or railroads in general; if not the latter, then it would appear that the road he has reference to has some local conditions, coupled with a shortage of power, that would make it difficult to always have a suitable engine to handle the different sizes of trains, or it shows a deplorable lack of supervision and organization to run engines of different capacity indiscriminately on all trains regardless of size.

The third paragraph, complaining of big engines on small trains and small engines on big trains, would indicate that there was absolutely no co-operation between the yard office

and the engine house. If the traffic superintendent had to explain to some superior officer who knew the game *why* the locomotives were not pulling 100 per cent trains, at least in one direction and give the reason in each individual case, there should be an improvement before long or a new man on the job.

Surely the assignment of engines should be placed where it belongs, viz., with the general superintendent and master mechanic of each district. They are in a position to know where to place the right proportion of light and heavy power. It is then up to the division officers to see that each engine has 100 per cent of its haulage capacity hooked on behind the tender and it is up to the road foreman or division master mechanic and locomotive foremen to see that they are kept in a condition to do it. If there is sufficient motive power on the division or territory in question to handle the traffic, or even if they are short of power occasionally, it is the duty of the chief despatcher to know just what is doing, and get suitable engines back to the terminals where they are required in time to be put in shape to do it.

On the road where I have the pleasure of working, the operating officials are very much concerned not that they have an engine big enough to haul the train, but that they have a big enough train for the engine to handle, and this is true in the month of July as well as the month of January with its 50 below zero.

In the last paragraph of his letter Mr. Clouser advises increasing the efficiency by giving some officer the job of knowing the whole road, weight of train, profile, condition of track, characteristics and condition of each engine on the road, train schedules and all the other things that affect the problem, and from these things, plan the distribution of the motive power, while he is keeping his eye on the order in which the engines come in and out of the shop, and in a general way see that the right engine is always available. This is quite a large sized order for this particular official, especially if he has a large territory to look after.

I don't think Mr. Clouser has solved the power problem of this particular road yet if he expects to get efficiency out of a "particular officer" who has assigned to him the multitude of duties that Mr. Clouser would hang on to him. Railroads are not run in a general way any more; in this country they are run by an organization, each one of which knows his particular part of the business and he has to put up the goods; then there is a blue print sent to him to let him know how he is getting along, and if the figures on this print do not compare favorably with performances in the past, then there is a note asking him "why" and his job depends on his explanation.

JOHN H. BROOKES,
Division Master Mechanic, Canadian Pacific.

NEW BOOKS

The Engineering Index for 1919. Published by the American Society of Mechanical Engineers, 29 West 39th Street, New York. 527 pages, 9 in. by 6 in. bound in cloth.

The purpose of the Engineering Index is to provide a convenient and satisfactory guide to engineering literature. The 1919 edition of this index is the most complete and comprehensive work of its kind ever published. It contains over 12,000 references to articles published during the year 1919 in nearly 700 engineering and allied technical publications. The compilation of this index is based upon a review of approximately 1,100 periodicals, reports, and other publications by the engineering staff of the American Society of Mechanical Engineers. These publications are printed in ten different languages and comprise what is probably the most complete collection of scientific and engineering publications in the world. All of the publications referred to in this index are now a part of the Engineering Societies' Library of New York.

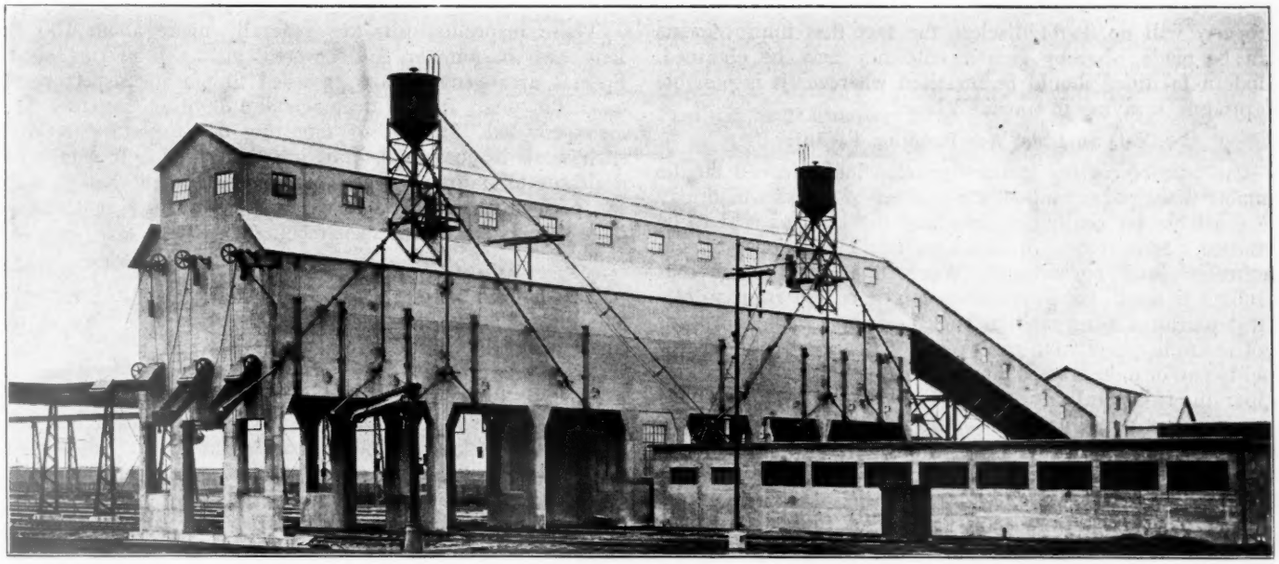
Practical Locomotive Running and Management. By W. G. Knight, 519 pages, 5 in. by 7 in., illustrated, bound in cloth. Published by the author, W. George Knight, 35 Cushing street, Medford, Mass.

This is the second edition of a very popular book on locomotive operation that is distinguished by its plain common sense treatment of the many difficult problems encountered by those responsible for the operation of locomotives. The first chapters of this book are devoted to the fundamental facts relating to combustion and the generation of steam. In this connection the function of the brick arch of the superheater and other smaller appliances essential to the efficiency and capacity of the locomotive are described. The maintenance as well as the operation of these devices is dealt with in a commendable manner. There is also a chapter on locomotive front end appliances with particular references to the effect of these appliances upon the operation of the locomotive. Locomotive valve gears and the air brakes are discussed in separate chapters. The chapter on locomotive running is one that could be read to advantage by any locomotive engineer or supervisor of locomotive operation. The final chapter, which deals with a general study of the modern locomotive, does not, of course, deal with this subject in its entirety but contains a good deal of information in a convenient form relating to the principles involved in the design and operation of these modern locomotives. It should be understood, however, that this book does not add any amount of original matter to the subject and would not appeal to anyone who has already made a thorough study of the entire field. The great value of the book will be found in its use as a reference and guide by enginemen, fuel and locomotive supervisors.

Fuel Oil in Industry. By Stephen O. Andros. 240 pages, 9 x 6 in. Illustrated. Bound in cloth. Published by the Shaw Publishing Company, 910 South Michigan Boulevard, Chicago.

The use of fuel oils by the railroads is by no means new and the problems involved in its application to the locomotive have been carefully studied by railway engineers for many years; in fact, the value of this book to the railway mechanical or civil engineers might be questioned if it were not for the tremendous expansion in the use of fuel oil in all industries within recent years. Thus the increased price of bituminous coal has assisted in promoting the use of fuel oil both in maritime service and in many hundreds of stationary plants along the eastern seaboard. This has introduced new problems relating to its transportation in bulk and storage in large quantities. Moreover, it must be admitted that refinements bearing upon the handling and burning of fuel oil are generally given more consideration in stationary and maritime service than in railroad use. For this reason, there is a field for a book of this character in railroad as well as industrial service which outlines as it does not only the principles of fuel oil combustion and the properties of fuel oil but the method of testing, storing and burning it, together with a full description of its application to industrial and domestic furnaces.

For instance, the book not only describes many of the details involved in the construction of steel storage tanks but refers to an interesting development in concrete oil storage tanks and describes at length all of the pipe setting and auxiliary machinery involved. While the book describes many types of burners that would not be applicable to locomotive service, still there are many points in connection with this subject as outlined in this book that will prove of particular interest to railway fuel engineers. The use of fuel oil in the manufacture of iron and steel and the heat treating furnaces is also described and illustrated in an interesting way.



1,600 *Ton Reinforced Concrete Coaling Station, C. of N. J., Communipaw, N. J., Serving Ten Tracks with Three Kinds of Coal*

Modernizing Existing Locomotive Terminals*

Important Details of Locomotive Terminal Design Outlined at Railway Section Meeting of A.S.M.E.

BY G. W. RINK
Asst. Supt. Motive Power, Central Railroad of New Jersey

LOCOMOTIVE terminals play an important part in the operation of the railroad, as the transportation department is at all times entirely dependent upon them for its supply of serviceable power for the movement of both passenger and freight cars. Should the capacity of the terminal or the facilities for making repairs be inadequate, the result will soon reflect itself in more time being required to prepare engines for service and more frequent detention on the road due to failures.

The general layout of engine terminals, also the extent of shop facilities provided, depends entirely on their location with reference to the general locomotive repair shop. When located in close proximity it is necessary to provide only such facilities as may be necessary to make the general run of roundhouse repairs, depending upon the main shop for the manufacture and supply of a large percentage of materials required for use at the terminal. But when engine terminals are located some distance from the general locomotive repair shops, they should be provided with enlarged facilities so as to perform all the necessary machine, blacksmith, and boiler-shop operations required when making more extensive repairs, and be entirely independent of the main shop. It is important, however, to eliminate at the terminals the manufacture of such standard parts as may be produced elsewhere at less cost. At outlying points where only light repairs are made to maintain locomotives in serviceable condition, such facilities as described above are not necessary.

At all important terminals the measure of efficient operation is the time required to prepare locomotives for service and the mileage which can be obtained between shoppings for class repairs. Any saving in time of course permits more intensive use of locomotives when transportation requirements make it necessary, but this saving can only be accomplished by providing a first-class terminal layout with proper equipment so as to enable the terminal organization to handle all engines with promptness and despatch. This requires a properly balanced organization to perform the various classes of work required and, coupled with modern labor- and time-saving facilities, should tend to reduce congestion materially and maintain the equipment properly.

Repairs at Locomotive Terminals

The location of the engine terminal with reference to the general locomotive repair shop will have some bearing on the necessity of performing relatively heavy repairs at the terminal. Where they are within reasonable distance of each other, it may be desirable to have a considerable part of the heavy repair work transferred to the main shop, where the repairs can be performed more expeditiously and the engine returned to service. On the other hand, this class of work has a tendency to interfere with the output of the locomotive repair shop, and especially so if it is found difficult to maintain the necessary quota of class repairs, considering the equipment as a whole. In such cases it would appear more desirable to increase the engine-terminal forces and provide sufficient facilities to at least make Class 5 repairs and the general run of heavy running repairs, including the removal and reapplication of a part or complete set of flues.

Where it is found desirable to perform such heavy repair work, it should preferably be done in a small building located adjacent to the machine shop, and provided with several tracks for holding engines and an overhead crane or power-driven locomotive screw hoist for the removal of all wheels.

This feature is very desirable, especially if heavy locomotives are to be handled. It also increases the track capacity within the roundhouse to that extent and repairs can be made more promptly and economically.

With reference to existing terminals, a careful study of the

*From a paper presented at the annual meeting of the American Society of Mechanical Engineers, December 8, 1920.

property will no doubt disclose the fact that improvements can be made whereby greater efficiency may be obtained. Modern facilities should be installed wherever it is possible to produce a saving in time and labor.

Coal, Sand and Ash Handling Facilities

The type of coaling stations selected must depend on the number of engines handled, the number of tracks which may be available for coaling engines and the kind of coal to be handled. Some roads in the East use bituminous, broken anthracite, and buckwheat. Where the quantity of coal handled is small, the locomotives can be coaled from an elevated platform using one-ton buckets or by means of a locomotive crane direct from car. When it is necessary to deliver coal to two or more tracks, a mechanical type of coal-handling apparatus is generally installed. Marked improvements have been made in receiving, hoisting and distributing equipment, which has resulted in smaller operating forces being required. Measuring devices are also installed for recording the amount of coal delivered to tenders. An electric winch should be provided at large terminals at the loaded coal-car track so that cars can be hauled to position over track hopper.

The sandhouse should be located at the coaling station. Sufficient wet-sand storage space should be provided as well as means for drying the sand by coal stove or steam. Compressed air should also be available so that the sand can be delivered to overhead storage bins, having suitable outlets to deliver the sand direct to engine by gravity. All important engine terminals should have a complete installation of this character.

During recent years the tendency when constructing large terminals has been to install pits filled with water. The cinders drop directly into the water and move toward the center of the pit, due to the outer wall sloping inwardly, and are removed either by a locomotive crane or by an overhead crane traversing the entire length of the cinder pit, the cinders being deposited by means of grab buckets directly into cars located on the loading track. The pit is filled with water to a depth of about five feet, water being admitted at one end of the pit and overflow provided at the opposite end. Provision is made to protect the floor of the pit against injury by the grab bucket, by imbedding old rails in the concrete. Due to the quantity of water required for large installations of this character, provision should be made if possible for a supply from a nearby stream or other natural source.

Steam-jet ash conveyors can be installed to advantage where ample supply of steam is available. The system consists of an 8-in. cast-iron pipe made exceedingly hard to withstand wear, with intakes provided at suitable intervals. The cinders are drawn by suction through the main pipe line and then propelled by means of the steam jet direct to car or storage bin, suitably located. Cinders handled in this manner are not wetted down until they enter storage bin, where a water spray is provided. This type of cinder conveyor has proved very satisfactory for handling cinders in power houses and should give good service when installed in connection with small engine terminals.

Inspection Pits

Inspection pits are now being installed at a number of large engine terminals. These are located on the inbound tracks with the view of making inspection of locomotives before they are placed over the cinder pit. Fires can then be withdrawn when the engines pass over the cinder pit, if inspection develops defects which warrant this procedure, thus saving time and expense involved if engine was inspected within the roundhouse after passing over cinder pit. There are many advantages in having inspection made at this time as the foreman by means of pneumatic tubes can be furnished with both the engineer's and inspector's reports showing work to be done before engines are placed in the shop.

These inspection pits are generally made about 100 ft. long, two in number, and covered with a protection shed. Special arrangements are provided to permit inspectors to enter the pits. Proper drainage and lighting facilities are also provided. In lieu of reporting on inspectors' reports such work as loose nuts, missing cotters, etc., it would be desirable to station at these inspection sheds mechanics who can perform this work at once, thus saving time in locating these defects in the shop after being reported.

Heating and Ventilation

Heating and ventilation is of first importance in a modern and efficient roundhouse. With the possible exception of small isolated houses in mild climates a properly designed system combining heating and ventilation should be adopted. An installation of this kind consists of a blower drawing air through hot-blast heaters located in a fan room which forms a projection on the outer wall of the roundhouse. The heated air is discharged through an underground concrete duct system.

A combined heating and ventilating system should supply sufficient air for the quick removal of smoke, gas and vapors. Ventilating sash, louvers and other openings should be provided at the high points of the room to supplement the forced system by directing the flow of air currents and facilitating the removal of hot gases. This feature should be carefully considered, for in roundhouse ventilation it is not so much a question of diluting the air as it is of establishing a positive flow of air which will carry the gases along with it.

It is sometimes necessary, due to the requirements of local ordinances or because the type of house prevents the use of smoke jacks above the locomotive stacks, to install an exhaust system so as to remove gases directly from the locomotive smokestacks. In the latter case connections are made to the smokestacks by means of swinging hoods. This system is not necessary from a ventilating standpoint, and should only be installed where conditions compel its use.

With the usual type of indirect system the fan rooms, one or two in number depending on the size of the house, should be located midway of the length of the house to be served, thereby reducing the temperature drop of the air in the duct as well as the friction head against which the fan must work. The quantity of air supplied together with the number, size and location of air outlets depends largely on the type, size, and location of the roundhouse. The amount of heat to be supplied with the air is also a variable factor and should have careful study so as to provide a comfortable working temperature under the conditions obtaining in roundhouse operation.

The question as to whether the fan should be motor- or engine-driven depends on the quantity of exhaust steam available for heating and whether or not it is desired to operate the fan for ventilation in the summer time. The hot-blast heaters should be operated through a two-pipe vacuum system, particularly where exhaust steam is available, so as to reduce the back pressure and provide a positive circulation of steam through all parts of the heaters. The temperature of the air can be regulated to suit the variable outside temperature by subdividing the heater into units with a control valve on each. The fan should be operated at a constant speed so as to make the ventilation independent of the heating and to provide a uniform condition at all times.

Lighting

Adequate daylight facilities through large window areas together with light, cheerful surroundings are highly desirable. The windows should be spaced and located so that daylight conditions are fairly uniform. They should also provide sufficient daylight so that artificial light will be required only during those portions of the day when it would naturally be considered necessary. Good natural and arti-

ficial light will reduce accidents, provide greater accuracy in workmanship and simplify the supervision of the men.

Much needed improvement is desired in connection with artificial lighting of engine terminals. In the roundhouse proper, lights mounted on the outer wall and reflected between engine pits have given satisfactory results when augmented by sufficient lights suspended from the ceiling to afford general illumination. Machine shops, etc., should be provided with a general or overhead lighting and also supplemented by individual lamps conveniently placed, preferably on brackets so that they may be adjusted.

For lighting the roundhouse circle, flood lights should be used whenever possible as general illumination will add considerably to the safe movement of locomotives to and from turntable and engine house. Ash pits can be illuminated by rows of reflector lights placed on poles, and similar provisions should be made at other points beyond turntable or by the use of flood lights on the tops of coaling stations. The introduction of many new types of lamps has made it possible to provide better illumination when changing from an old to a new lighting system. A study should be made of the conditions and proper lamps selected for the purpose.

Modern Ash Pit of the Central of New Jersey

Hot-Water Washout and Refilling System

Facilities should be provided for washing out boilers, using hot water under pressure and refilling with hot water after washing. There is an actual saving in time as compared to the old system of washing out and refilling with cold water; with this system boilers are washed out more thoroughly and strains within the boiler due to expansion and contraction are considerably reduced, with the result that the cost of boiler maintenance is reduced.

There are two types of installations for this purpose in general use, one of which utilizes the blow-off water for washout purposes only, while the other utilizes as much of the blow-off water as necessary for this purpose and the remainder, after being clarified, for refilling purposes. As blow-off water is always soft and becomes clarified soon after storage, it is of course the best water for the generation of steam and its reuse in this manner is responsible for the greater efficiency of the latter type of installations.

Hot-water washout and refilling systems can be economically installed in any size to meet the requirements in any engine terminal of moderate size. The usual practice is to deliver washout water at temperatures varying from 100 deg. to 140 deg. The refilling water generally has an average temperature of approximately 210 deg. Where such systems have been introduced, there is a material reduction in time required to do this work. Boilers have been blown off, refilled, fired, and steam pressure brought up to 100 lb. within from two to three hours. This does not include such time as may be required to make necessary repairs to boilers.

Wheel-Dropping Facilities

The usual wheel-dropping facilities consist of a drop-pit system which provides for depressed pits at right angles to shop track, using telescoping pneumatic or hydraulic jacks for lowering and raising wheels, separate pits and jacks being installed for handling driver and engine-truck wheels.

Screw-jack locomotive hoists especially designed for unwheeling locomotives are being more extensively used at engine terminals, and their use has made possible a larger saving in both time and labor. These hoists operate with a high degree of safety as compared with the drop-pit system; furthermore they can be located within the roundhouse or installed in a separate building, in which case it would be desirable to also install the wheel lathe and other tools and appliances for taking care of heavy running repairs.

When screw-jack locomotive hoists are installed, it does not eliminate the necessity for providing drop pits in the roundhouse, which may be needed in order to prevent loss of time in making repairs to locomotives which may only require the dropping of a single pair of drivers or engine-truck wheels.

Machine, Boiler and Smith Shops

Old and obsolete tools should be replaced by modern machine tools, which insure increased production at lower costs and the work being done more accurately and promptly and power maintained in better condition. Individual motor drive for the larger machines and group drive for the smaller machines are preferable. Facilities should include steam hammer, forges with down-draft hoods (number and size to suit work to be performed), punch and shear, plate-bending rolls, straightening plate, flange fire, etc.

Autogenous cutting and welding outfits are also considered indispensable and are used principally in making repairs to locomotive fireboxes, engine frames and in reclaiming miscellaneous parts which can readily be repaired by means of this process.

The Power House

Important engine terminals should be provided with a power plant of sufficient size to take care of the future as well as immediate needs of the terminal. In a number of cases this plant is required to provide steam for thawing snow at switches on main-line track leading to the terminal passenger station and supply heat and light to station buildings, and function in general as a service station. Labor-saving devices should be installed in the way of coal- and ash-handling machinery, automatic stokers and large-capacity overhead coal-storage bunkers. Consideration should be given to operating with condensers, requiring a cooling tower if fresh water is used, the surplus water being delivered to flood ash pit for locomotive cinders if this type is used. Tanks of ample capacity should be located at power house with water mains of proper size supplying water for shop use and filling of tenders at terminal tracks, locating water columns away from switches in cold climates to prevent freezing. At smaller terminals, discarded locomotive boilers are used to furnish steam for power and heat. A close study made of these installations will reveal the fact that in many cases money can be saved by the use of modern water-tube boilers.

Discussion

The discussion of this paper was featured by the remarks of a representative of the operating department of the Penn-

sylvania Railroad, Mr. Wm. Elmer, division superintendent at Altoona. Mr. Elmer discussed the most important phases of the locomotive terminal situation with particular reference to its effect upon locomotive performance on one of the busiest railroad divisions of the United States. Confronted with the problem of getting the utmost service out of every available locomotive, Mr. Elmer has developed a unique system of records indicating the service performed by each locomotive on his division which he described at some length in the course of his discussion.

The paper on Modernizing Locomotive Terminals was also discussed by representatives of the Robinson and Austin Construction Companies who have recently been engaged in very extensive terminal development. Appropriate emphasis was laid on some of the most vital features in terminal construction and an attempt was made to demonstrate that the value of terminal improvements can be arrived at by capitalizing the enhanced earning power derived from locomotives handled in modern vs. obsolete terminals.

The discussion was closed by L. G. Plant, associate editor of the *Railway Mechanical Engineer,* who stated that consideration of the locomotive terminal from any angle would be incomplete if it did not place sufficient weight on the outstanding function of the terminal, which is to expedite the movement of locomotives, and emphasized those features of terminal development which have the most direct bearing upon the time element involved in handling locomotives.

Grease Lubrication

BY T. J. HOLMES
Swain Company, Chicago

Friction prevents machinery from being efficient. One writer gives it as his opinion that 50 per cent of the power used in the United States is wasted on unnecessary friction.

The economical running of all kinds of machinery depends largely upon the character and application of the lubricant. From the smallest to the largest and most complicated machine, the question of lubrication is of foremost importance. The cost of a lubricant is often very small in comparison with the amount of loss that may be sustained through friction, if an inefficient lubricant is used.

The parts of a bearing cannot be turned absolutely true and smooth. Rough places not visible to the naked eye are likely to exist. If these are ground together without lubrication, friction and heat result. The lubricant is employed to fill in the bearing, and to prevent friction. As a means of filling up any rough places in a bearing, a lubricant which carries a small amount of flake graphite or mica may be used to good advantage.

The following discussion applies only to those bearings where a stiff grease lubricant should be used. The term "grease" strictly applies only to animal fats, especially when in a soft state. In recent years, however, the term has been enlarged to include other products, but it properly includes only those possessing unctuousness or a soapy, slippery feeling in a marked degree.

What particular thing is there in grease that gives it lubricating qualities? This question has long puzzled persons interested in lubrication. Experience and investigation have led to the conclusion that the lubricating quality of grease is largely produced by fatty particles or colloids, constantly in motion, which are characteristic of the structure of grease. Greases which have not been subjected to high temperature possess great lubricating qualities, while those greases which have been subjected to a high temperature, either in refining or in use on hot journals, do not have the best lubricating qualities. Heat is destructive of the moving colloids, and therefore destructive of the lubricating qualities of a grease.

Any material used as a lubricant should have the following qualities:

(1) Adhesion, the property which causes it to cling to the surface to be lubricated. It is well known that certain fats cannot be entirely rubbed off a smooth surface and that water will not remove them. Soap and water must be used in order to remove them effectually.

(2) Cohesion, the property causing the particles of a lubricant to hold together.

(3) Unctuousness, that property which gives a greasy, slippery feeling to the touch.

The lubricating colloids seem to have much to do with all three of these necessary qualities and without their presence any material is of little or no value as a lubricant.

Tests for melting point and flash, as applied to lubricants, would therefore seem to be of little use in determining lubricating qualities. To judge lubricating qualities, tests should more properly be aimed at the determination of the relative amount of lubricating colloids in the make up of the material.

It is generally conceded that a good lubricant should be neither strongly acid nor strongly alkali, but should be neutralized so that no injury may result to the bearings or to the essential qualities of the lubricant.

Action of the Lubricant

When the bearing is perfectly adjusted and the journal started in motion, the lubricant is gradually drawn down around the journal, filling the entire space between the journal and box, and adhering to both wearing surfaces. The colloidal globules permit the journal to roll and slide over them, and at the same time they slip or roll past each other. This motion of the particles of the lubricant takes place without friction and consequently without the generation of heat.

If a journal is removed after running in a grease lubricant, a magnifying glass will disclose a thin film or coating. This film may be destroyed by heat, by foreign substances, or mechanical defects in the machinery. Furthermore, if the lubricant contains few colloids, the running of the journal may be accompanied by high friction and the generation of a large amount of heat.

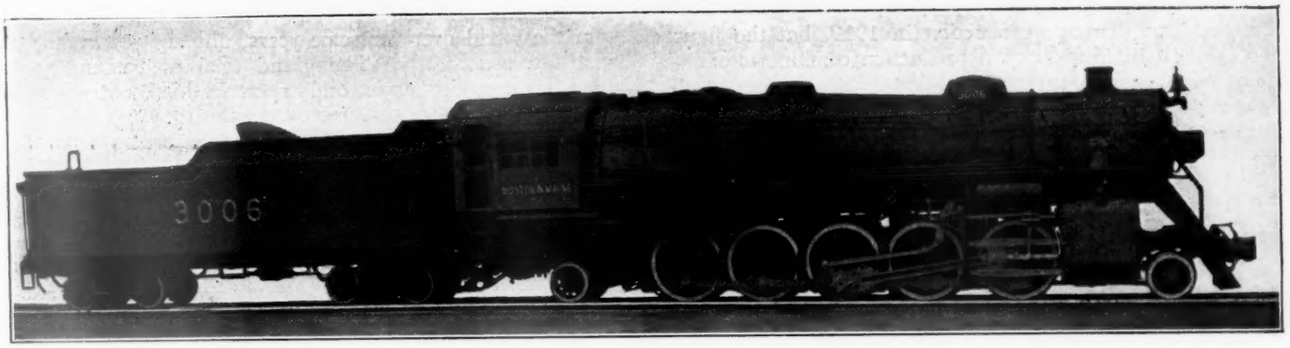
Every lubricant has its own lubricating temperature; that is, a point at which it yields the greatest degree of efficiency. The lubricating point should be low as no bearing should be permitted to "get hot." The efficiency point in a lubricant should not be confounded with the melting point. These two temperatures are often far separated and have little relation to each other. This relation varies with the materials used as lubricants.

As a rule, the degree of running temperature indicates the quality of the lubricant, but it may also be affected by the character of the work, or by mechanical defects in the bearing. Graphite or mica, although not lubricants themselves, may be used in moderate quantities to advantage in grease lubricants as they tend to fill up and smooth over rough or pitted bearing surfaces.

When machinery stands idle for a time, the weight of the journal is apt to force the lubricant out of the bearing, and it takes a little time for the re-establishment of a complete lubricating film. When a proper lubricant is used, the rotation of the journal will permit enough of the lubricant to work out at the ends of the box, to form rings which exclude moisture and dirt from the journal when it is not in motion.

It is necessary, not only to have good bearings and lubricants, but to have the lubricant applied by the proper method. The lubricator cup should fit tight and exclude all dust and grit. Indicators should be used on all bearings. Concealed lubricators often give rise to costly trouble because inspection cannot be readily made.

A poor system of lubrication, once installed, is difficult to change. It is advisable, therefore, when planning a new shop, that lubrication receive careful attention.



One of Twenty Santa Fe Type Locomotives Built by the American Locomotive Company for the Boston & Maine

Locomotives and Cars Ordered and Built in 1920

Considerable Increases Over 1919 Figures But Little Progress in Making Up Accumulated Shortage

THE locomotives ordered by the Class 1 railroads in 1920, according to the statistics of the Railway Age, reached a total of 1,668—almost eight times the number ordered for all domestic service in 1919. The orders placed by other railroads in the United States amounted to 103 and by industrial concerns to 227, making a total of 1,998 for all domestic purchases—more than nine times the similar total for 1919.

The orders by Canadian roads and industries from builders either in Canada or the United States were 189 and the orders received by American builders from foreign countries amounted to 718, making a grand total for all orders of 2,905. In 1919 the total Canadian orders were 58 and the foreign orders 898. Thus it will be seen that there was a considerable increase in orders from every source except in the export trade. Here the 1920 total is 180 less than the 1919 figure.

TABLE I—LOCOMOTIVE ORDERS OF 1920

For Class 1 Railroads	1,668
For Other American Railroads	103
For Domestic Industrials	227
Total Domestic	1,998
For Service in Canada	189
For Export to other Countries	718
Grand Total	2,905

The year 1919 set the low mark for locomotive orders as far back as records have been kept. In view of this fact, the 1920 orders cannot be considered excessive, as may easily be seen by reference to Table II. The totals for 1916, 1917 and 1918 all exceed the figures for 1920. The totals for 1917 are as large again as the figures shown in the present compilation. During these years greatly increasing demands on the railways together with a steady upward movement of prices which looked as if it would continue indefinitely brought about an economic condition which generally increases buying in almost every field. Then, too, during the war period it was felt that something approaching an adequate number of locomotives had to be provided regardless of cost, and under the regime of the Railroad Administration government credit was available for such purposes.

The orders this year were financed by the railroads themselves, with some help from the government to be sure, during the period of readjustment attendant upon the return of the carriers to their owners, when railway costs were nearing their peak and before adequate returns had been provided by a new rate structure. In view of these facts the showing for 1920 is not entirely unsatisfactory, although it is quite evident that nothing has been done during the past year to make up for deficiencies in the annual purchases of locomotives which have been accumulating since 1912.

The foreign orders for 1919 made up more than 75 per cent of all orders placed. In 1920 conditions were quite different, because foreign orders have been small. This decrease in orders from abroad is disappointing; it can be traced to the premium on the dollar which has increased generally throughout the year in most countries and which makes it possible in some cases for foreign manufacturers to underbid our own; to the fact that foreign competitors have been able to increase their production and to direct their efforts once more to their old markets; and to the generally impoverished condition of the countries which most need to replenish the inadequate stock of locomotives on their railways. One of the most noteworthy orders from foreign countries which was placed in the United States during the year was from Roumania for 50 locomotives. This order was divided equally between the Baldwin Locomotive Works and the American Locomotive Company and payment for it was made in petroleum.

TABLE II—ORDERS FOR LOCOMOTIVES SINCE 1901

Domestic Orders Only

Year	Locomotives	Year	Locomotives
1901	4,340	1908	1,182
1902	4,665	1909	3,350
1903	3,283	1910	3,787
1904	2,538	1911	2,850
1905	6,265	1912	4,515
1906	5,642	1913	3,467
1907	3,482	1914	1,265

Domestic and Foreign

Year	Domestic	Foreign	Total
1915	1,612	850	2,462
1916	2,910	2,983	5,893
1917	2,704	3,438	6,142
1918	2,802	2,086	4,888
1919	272	898	1,170

The number of locomotives built in the United States for domestic service during 1920 was 1,857 and for export 1,582, making a total of 3,439. In Canada the production was 165 for domestic use and 68 for export, making a total of 233 and a grand total of all production in the United States and Canada of 3,672. This figure represents an increase of 400 over the similar total, 3,272, for 1919. The total built in the United States for domestic service in 1920 is some 200

less than the domestic production in 1919, but the figures for the Canadian and export production combine to show a definite increase in the grand total.

Due to the failure of two large locomotive builders to furnish figures showing the number built for export, it has been necessary to estimate the production of these builders from other sources, which, however, are believed to be sufficiently accurate for purposes of comparison.

If the locomotive orders for the preceding year give any data by which production for the following year may be estimated, we can safely assume that the output of locomotives in 1921 should exceed measurably the production for 1920. The fact confronts us always that American roads have for several years fallen far behind in acquiring new motive power and that sooner or later the lack must be made good.

TABLE III. THE LOCOMOTIVES BUILT

	United States	Canada	Total
Domestic	1,857	165	2,022
Foreign	1,582	68	1,650
Total	3,439	233	3,672

Comparison with Previous Years

Year	Domestic	Foreign	Total	Year	Domestic	Foreign	Total
1896	866	309	1,176	1908*	1,886	456	2,342
1897	865	386	1,251	1909*	2,596	291	2,887
1898	1,321	554	1,875	1910*	4,441	314	4,755
1899	1,951	514	2,475	1911*	3,143	387	3,530
1900	2,648	505	3,153	1912†	4,403	512	4,915
1901	...	...	3,384	1913†	4,561	771	5,332
1902	...	...	4,070	1914†	1,962	273	2,235
1903	...	...	5,152	1915†	1,250	835	2,085
1904	...	...	3,441	1916†	2,708	1,367	4,075
1905*	4,896	595	5,491	1917†	2,585	2,861	5,446
1906*	6,232	720	6,952	1918†	3,668	2,807	6,475
1907*	6,564	798	7,362	1919†	2,162	1,110	3,272

*Includes Canadian output.
†Includes Canadian output and equipment built in railroad shops.

TABLE IV. THE PASSENGER CAR ORDERS OF 1920

For Class I Railroads	1,115
Other Domestic (including Pullman Co.)	666
Total Domestic	1,781
For Service in Canada	275
For Export to other Countries	38
Grand Total	2,094

More Passenger Cars Ordered and Built

The totals for orders of passenger cars during the past year show an upward trend. A total of 1,115 cars was ordered by Class I roads during the year and 666 by other railroads and private car companies in the United States, including the Pullman Company. These figures added together give 1,781 as a total for the year's domestic orders, a figure which compares quite favorably with the orders in 1917 and 1918—as well as 1919.

TABLE V. ORDERS FOR PASSENGER CARS SINCE 1901

Domestic Orders Only

Year	Passenger cars	Year	Passenger cars
1901	2,879	1909	4,514
1902	3,459	1910	3,881
1903	2,310	1911	2,623
1904	2,213	1912	3,642
1905	3,289	1913	3,179
1906	3,402	1914	2,002
1907	1,791	1915	3,101
1908	1,319		

Domestic and Foreign

Year	Domestic	Foreign	Total
1916	2,544	109	2,653
1917	1,124	43	1,167
1918	131	26	157
1919	639	143	782

Canadian orders for the year were 275—72 less than the 1919 figure. Export orders have dropped even more sharply. Export orders for 1920 were only 38, which is a rather poor showing in comparison with the total of 143 in 1919. Passenger car building has, however, been at a minimum the world over for some years, although eventually it must increase greatly. The grand total of passenger car orders for domestic service and export in this country and in Canada was 2,094—1,312 more than the 1919 figure, an increase brought about entirely by greater orders from the roads and other buyers in the United States.

The production of passenger cars during 1920 in the United States for domestic use was 1,272 (including cars for Pullman Company service) and for export 168. These figures show decided improvement over the similar figures, 306 and 85 respectively, for 1919. The cars built are described as: all steel, 1,240; steel underframe only, 171; wood, 21, and not specified, 8.

TABLE VI. PASSENGER CARS BUILT

	United States	Canada*	Total
Domestic	1,272	....	....
Foreign	168	....	....
	1,440	....	....

*Complete details Canadian production not received.

Comparison with Previous Years

Year	Passenger: Domestic	Passenger: Foreign	Passenger: Total
1899	1,201	104	1,305
1900	1,515	121	1,636
1901	1,949	106	2,055
1902	From 1902 to 1907 passenger		1,948
1903	car figures in these two		2,007
1904	columns included in corre-		2,144
1905*	sponding freight car columns.		2,551
1906*	.....	...	3,167
1907*	.....	...	5,457
1908*	1,645	71	1,716
1909*	2,698	151	2,849
1910*	4,136	276	4,412
1911*	3,938	308	4,246
1912†	2,822	238	3,060

*Includes Canadian output.
†Includes Canadian output and equipment built in company shops.

Year	United States: Domestic	United States: Foreign	United States: Total	Canadian: Domestic	Canadian: Foreign	Canadian: Total	Grand Total
1913	2,559	220	2,779	517	....	517	3,296
1914	3,310	56	3,366	325	....	325	3,691
1915	1,852	14	1,866	83	....	83	1,949
1916	1,732	70	1,802	37	....	37	1,839
1917	1,924	31	1,955	45	....	45	2,000
1918	1,480	92	1,572	1	....	1	1,503
1919	306	85	391	160	....	160	551

Most of the larger orders for passenger equipment were placed relatively early in 1920. The car building companies started the year with orders for domestic service on hand and undelivered amounting to 407. The traffic congestion, the difficulty of securing raw material and related conditions prevented them from getting production under way with any great degree of speed. The orders on hand at the end of November had reached a total of 925.

Freight Car Orders Increase; Production Still Low

In the number of freight cars ordered during 1920 there has been, as was the case with the locomotives, a remarkable improvement over the 1919 showing. The orders by Class I roads were 51,250 cars, by other domestic roads 1,044 and by private car lines and industrials 31,913—making a total of 84,207 cars ordered in the United States for domestic service. To this figure are added the total orders of 12,406 placed by Canadian roads and industries and 9,056 ordered by foreign buyers, which brings the total orders received in this country and Canada during the year up to 105,669.

TABLE VII. THE FREIGHT CAR ORDERS OF 1920

For Class I railroads	51,250
For other American railroads	1,044
For private car lines and industrials	31,913
Total domestic	84,207
For service in Canada	12,406
For export to other countries	9,056
Grand total	105,669

In 1919 the total domestic orders were 22,062—scarcely one-fourth the 1920 total. Canadian orders of 3,837 for 1919 are scarcely a third of the purchases for 1920 and the export orders of 3,994 are less than one-half the total purchases for export during 1920.

As was pointed out in the review of the locomotive orders for this year, the showing for freight car orders is not entirely unsatisfactory in view of the uncertain conditions which prevailed throughout the greater part of the period, even the close of which brought no conclusive proof that the rate structure provided by the Interstate Commerce Commission was going to provide adequate returns to the carriers. The fact remains, however, that the acquisitions of freight cars in 1920 were far from sufficient to make up the deficiencies in orders which have accumulated during the past eight years. The showing of freight car orders for 1920 does not even compare favorably with the totals for any recent year with the exception of 1914 and 1917. The domestic orders in 1918 alone were for some 40,000 more than in 1920.

TABLE VIII. ORDERS FOR FREIGHT CARS SINCE 1901

Domestic Orders

Year	Freight cars	Year	Freight cars
1901	193,439	1908	62,669
1902	195,248	1909	189,360
1903	108,936	1910	141,024
1904	136,561	1911	133,117
1905	341,315	1912	234,758
1906	316,315	1913	146,732
1907	151,711	1914	80,264

Domestic and Foreign

Year	Domestic	Foreign	Total
1915	109,792	18,222	128,014
1916	170,054	35,314	205,368
1917	79,367	53,191	132,558
1918	123,770	53,547	177,317
1919	25,899	3,994	29,893

By far the greater part of the orders for 1919 were from private car lines. It is pleasing to note in connection with the 1920 totals, that, although the orders from private car lines are practically twice the 1919 figures, the railway orders are nevertheless much larger than those from the private buyers.

The export orders for 1920 are more than twice the total for 1919, but far below the average for the preceding four years. This falling off may be explained in the same manner as was the decline in locomotive orders from abroad, i. e., the premium on the dollar in foreign countries, the return of foreign manufacturers into active competition and the generally impoverished condition of buyers throughout the world.

Freight car production in the United States during 1920 for domestic service was 60,955 and for export 14,480, making a total of 75,435 cars built in the United States during the year. The totals for 1915 only in recent years are lower than those for the past year. This decline in production is but the natural outcome of the few orders placed during 1919. The heavier orders during 1918 gave 1919 an excellent showing from the standpoint of production in spite of the fact that the orders during 1919 were much lower than usual.

The production for export in 1920—14,480—represents a decline of more than 75 per cent over the 1919 figures. The production for export in 1919 bore a large ratio to the total production and the domestic orders a small ratio to the total. This condition has not obtained during the year just past and indeed the small total for export may well occasion some concern. It is true that foreign buyers are not acquiring new equipment in anything like the quantities which they actually require, but it is also evident that manufacturers abroad are once more directing their efforts toward regaining the markets lost to American concerns during the war and that the premium on the dollar gives them an opportunity in many cases to underbid American manufacturers.

In addition to the number of cars built and ordered during the year the Railway Age also asked the manufacturers for details regarding the type of cars built. The following details concerning the construction of cars built in the United States may be of interest. All-steel, 34,140; steel frames only, 6,537: steel underframes only, 22,862; steel center sills only, 635; all-wood, 2,451; not specified, 8,810.

If the orders for the preceding year are any measure of production for the following year, and it would seem that they are, the production in 1921 should greatly exceed the 1920 total. Orders in 1918 were comparatively high and production in 1919 was high. Few orders in 1919 resulted in low production totals for the past year. In like manner, then, orders having increased greatly in 1920, production in 1921 should show considerable advances. It is well to point out in this connection that the greater part of the orders for cars in 1920 were placed in the earlier part of the year but that conditions of transportation were such and raw material so difficult to secure that the manufacturing plants are only now getting up to anything like capacity production. The output of the car building companies has averaged only 3,000 cars a month for the greater part of the year. In October and November it reached 6,000.

TABLE IX. FREIGHT CARS BUILT

	United States	Canada*	Total
Domestic	60,955	.....	.....
Foreign	14,480	.....	.....
	75,435	.....	.....

*Complete details of Canadian production not received.

Comparison with Previous Years

Freight

Year	Domestic	Foreign	Total
1899	117,982	1,904	119,886
1900	113,070	2,561	115,631
1901	132,591	4,359	136,950
1902	161,747	2,800	162,599
1903	153,195	1,613	152,801
1904	60,955	1,995	60,806
1905*	162,701	5,305	165,155
1906*	236,451	7,219	240,503
1907*	280,216	9,429	284,188
1908*	75,344	1,211	76,555
1909*	91,077	2,493	93,570
1910*	176,374	4,571	180,945
1911*	68,961	3,200	72,161
1912†	148,357	4,072	152,429

*Includes Canadian output.
†Includes Canadian output and equipment built in company shops.

Year	United States			Canadian			Grand Total
	Domestic	Foreign	Total	Domestic	Foreign	Total	
1913	176,049	9,618	185,667	22,017	.....	22,017	207,684
1914	97,626	462	98,088	6,453	.....	6,453	104,451
1915	58,226	11,916	70,142	1,758	2,212	3,970	74,112
1916	111,516	17,905	129,421	.....	.....	5,580	135,001
1917	115,705	23,938	139,643	3,658	8,100	11,758	151,401
1918	67,063	40,981	108,044	14,704	1,960	16,664	124,708
1919	94,981	61,783	156,764	6,391	30	6,421	163,185

Photo from Keystone View Co., Inc., of N. Y.

Railroad Through a Coffee Plantation

Car and Locomotive Prices Reached Peak in 1920

Equipment Ordered During Year Cost Two and One-Half to Three Times 1910-1914 Average

THOSE railroads that purchased locomotives in 1920 paid prices for them averaging about two and one-half times the pre-war prices. The prices of freight cars were even higher in proportion than this, all-steel cars being priced at three times the pre-war figures and cars of composite construction at more than three times the pre-war prices. The increase in passenger car prices was not as pronounced, the 1920 values having been slightly over twice the 1910 to 1914 average. These are the principal facts brought out by a study of equipment prices recently conducted by the Railway Age.

Detailed figures are given in this article showing this price relationship as between 1920 and the pre-war period. There is also given a table showing the prices paid for the U. S. R. A. standard equipment allocated to the railroads and, what is more important, data showing the prices which have been paid by a number of railroads for equipment which they have ordered in 1920. For purposes of showing more particularly the price trend during the year, there are also shown details of the prices of the basic iron and steel commodities which enter into the manufacture of all types of railway motive power and rolling stock.

Table I is a chart compiled for valuation purposes by the President's Conference Committee on Federal Valuation. The chart represents careful studies made by the engineers of that organization in co-operation with the equipment builders. The studies cover 10½ years, and to derive the figures shown, data were assembled covering the prices of 10,500 locomotives, nearly 275,000 freight cars and some 1,600 passenger coaches. The prices in all instances were "as sold" and cover the date of sale, not the date of delivery. The base price of 100 in the chart is taken for the period 1910 to 1914, both inclusive. The comparative percentages are worked out for the years 1910 to 1919 and for the first

TABLE I—COMPARISON OF PRICES OF EQUIPMENT, BASED ON DATA RECEIVED FROM SIX PRINCIPAL EQUIPMENT COMPANIES IN THE UNITED STATES, USING THE WEIGHTED AVERAGE PRICE OF 1910 TO 1914 AS 100 PER CENT OR "BASE"

Prices as sold 1910-14, inclusive. Year or period	Locomotives	Freight cars			Passenger Coaches		
		All steel	Composite wood and steel	All wood	All steel	Composite wood and steel	All wood
	147.7096 dollars per ton	2.57 cents per pound	2.51 cents per pound,	2.26 cents per pound.	11.24 cents per pound.	9.91 cents per pound.	9.22 cents per pound.
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
1910–1914, inclusive. Base	100	100	100	100	100	100	100
1910	98	104	105	102	115	105	106
1911	98	89	92	96	95	106	90
1912	100	93	98	102	93	91	108
1913	107	110	113	93	98	96	107
1914	93	97	94	100	96	100	...
1915	100	102	101	93	82	...	...
1916	143	156	146	141	106	...	...
1917	210	199	169	201	132	...	...
1918	206	247	253	...	163*	...	...
1919	212	...	...	...	199*	...	...
1920 (first six months)	251	300	313	...	218	...	...

*Car companies report no steel passenger coaches contracted for in 1918 and 1919. Per cents for 1918 and 1919 estimated by car companies.

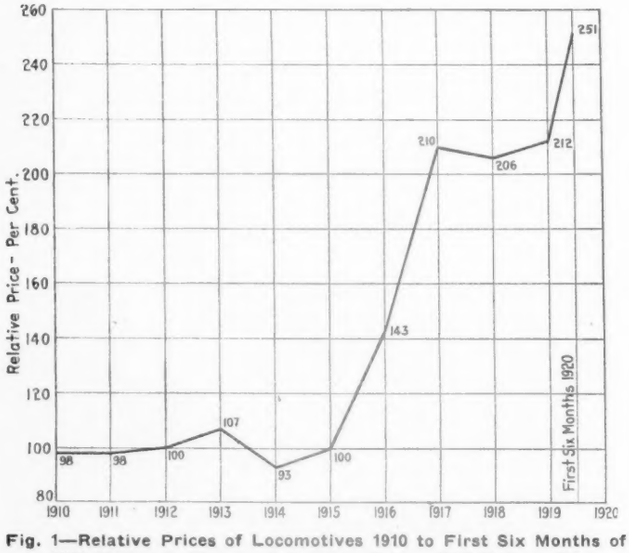


Fig. 1—Relative Prices of Locomotives 1910 to First Six Months of 1920 Shown in Terms of Average Prices 1910-1914 as 100

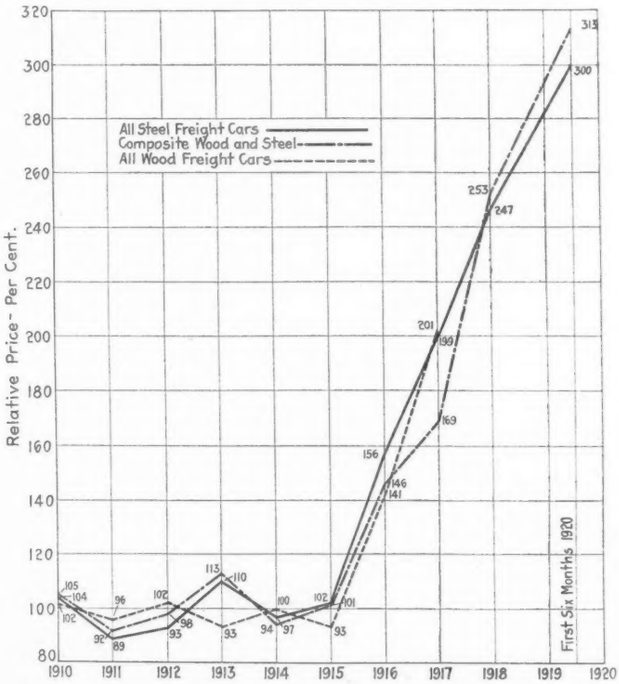


Fig. 2—Relative Prices of Freight Train Cars, 1910 to First Six Months of 1920 Shown in Terms of Average Prices 1910-1914 as 100

six months of 1920; the last figures are the ones of chief interest in this connection. The prices for the first six months of 1920 are given in the following percentages of the 1910-1914 base price:

Locomotives	251
Freight cars:	
All-steel	300
Composite	313
Passenger coaches	218

In using the figures for the first six months it must be borne in mind that approximately two-thirds of all the orders placed during the year were placed before July 1. The price trend for the year was slightly upward from January to May or June. It then ran on a level to about the latter part of October, and since that time it has fallen to slightly below the January figure. In view of these facts, and that but few orders have been placed in the last three months, it is apparent that the percentages given for the first six months are quite representative of the greater part of the orders placed for the entire year.

Table II giving the prices paid, or to be paid when finally ascertained, for the allocated U. S. R. A. standard equipment, needs but little comment. These prices are those set in connection with the equipment trust agreement made last spring to finance these cars and locomotives. They are, of course, for the year 1918, that being the year in which the orders were placed. It is interesting to note in this connection that Table I shows no freight car percentage for 1919, no orders having been reported for that year in the valuation studies.

Table III gives in detail the prices paid per unit for a large proportion of the cars and locomotives, orders for which were placed during 1920. The information is made available this year for the first time through the publicity given applications of the carriers for loans from the revolving fund or in the case of the approval by the Interstate Commerce Commission of issues of equipment trust certificates. The carriers show in their applications the details of the expenditures which the loan or equipment trust issue covers. The commission has adopted a policy of making this information public when its action, favorable or otherwise,

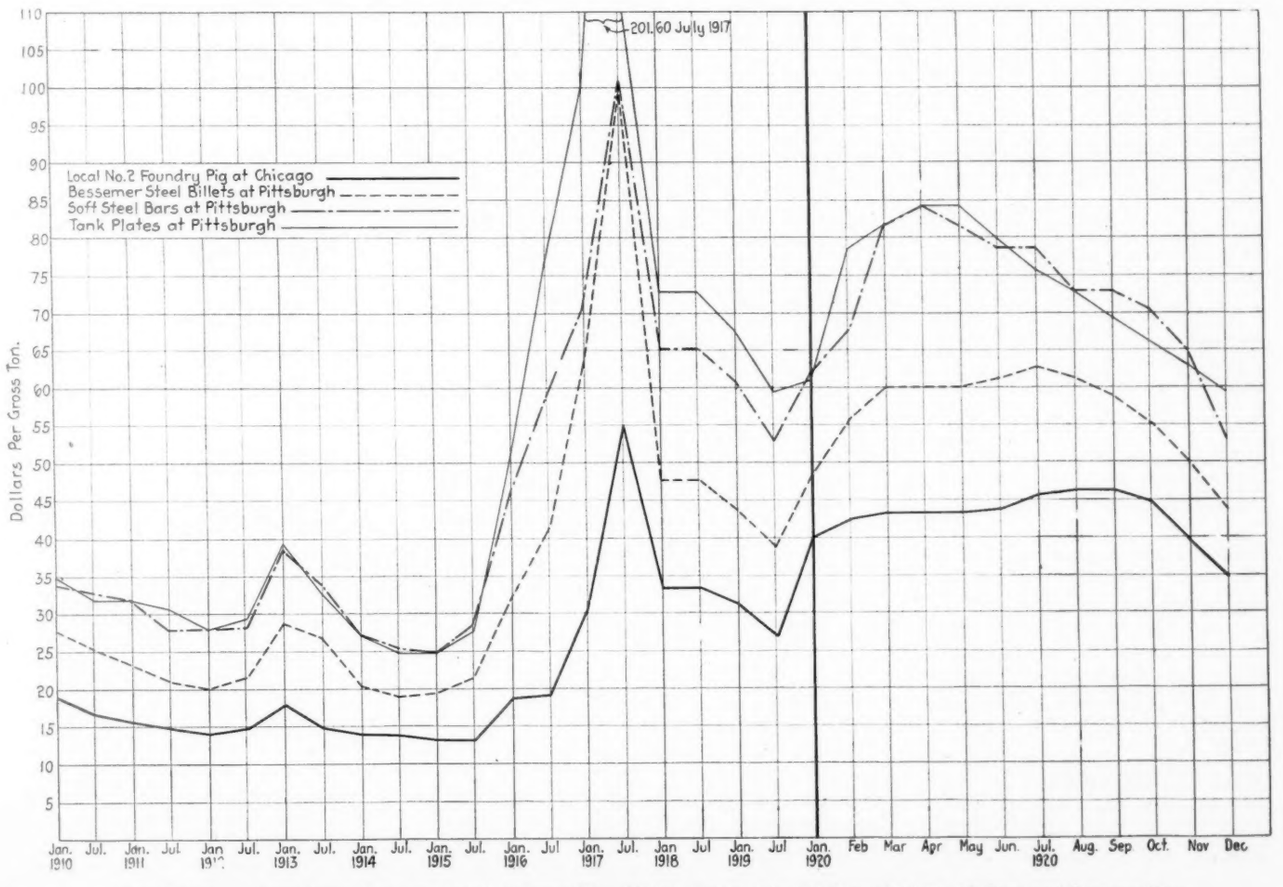
TABLE II—PRICES OF U. S. R. A. STANDARD AND OTHER ALLOCATED EQUIPMENT

Type	Capacity	Construction	Maximum price	Minimum price
Sgle. sh. box	100,000	St. frame	$3,072.45	$2,815
Dble. sh. box	80,000	St unf.	2,932.40	2,725
Hopper	110,000	Steel	2,829.32	2,505
Gondola	100,000	Comp.	2,745.01	2,645
L. S. gondola	140,000	Steel	3,212.85	3,100
P. R. R. hopper	140,000	Steel	*3,488.00	.....

LOCOMOTIVES

Type	Weight lb.	Maximum price	Minimum price
Lt. Mikado	290,800	$53,556	$49,400
Hvy. Mikado	320,000	58,529	51,850
Lt. Mountain	320,000	56,995	55,000
Hvy. Mountain	352,000	61,782	55,700
Lt. Pacific	270,000	51,200	49,575
Hvy. Pacific	300,000	54,025	52,300
Lt. Santa Fe	352,000	62,003	55,975
Hvy. Santa Fe	390,000	67,317	60,450
Lt. Switch (0-6-0)	165,000	36,019	31,675
Hvy. Switch (0-8-0)	214,000	43,912	37,750
Lt. Mallet (2-6-6-2)	440,000	78,322	71,650
Hvy. Mallet (2-8-8-2)	540,000	91,958	81,575
30 P. & R. Consol	.....	59,029	51,678
26 B. & O. Mallet	.....	87,830	83,400
11 C. of N. J. Mikado	.....	60,529	53,500
3 K. C. S. Facific	.....	*51,000	.....
7 T. & P. Facific	.....	*52,955	.....
16 T. & P. Santa Fe	.....	*59,914	.....
2 T. & P. Santa Fe	.....	*59,089	.....
5 Ft. W. & D. C. Pacific	.....	*50,298	.....

* Flat price.



The Prices of Four Basic Iron and Steel Commodities Which Enter Into the Manufacture of Cars and Locomotives

TABLE III—EQUIPMENT ORDERED IN 1920

Locomotives

Road	No.	Type	Weight	Builder	Price Each	Price Total
Ann Arbor	3	0-8-0	200,000	American	38,925	116,775
Atlantic Coast Line	25	4-6-2	277,000	American	57,407	1,435,175
	5	0-6-0	163,600	Baldwin	47,600	238,000
Baltimore & Ohio	50	2-8-2	300,000	Baldwin	84,000	4,200,000
Bangor & Aroostook	6	2-8-0	211,000	American	60,000	360,000
Central of Georgia	7	4-8-2	316,000	American	67,857	475,000
Chesapeake & Ohio	20	2-6-6-2	441,000	American	89,990	1,799,800
	5	0-10-0	295,000	American	63,650	318,250
Chicago & North Western	40	2-8-2	302,000	American	73,413	2,936,520
	20	4-6-2	260,000	American	66,625	1,332,500
Chicago Great Western	10	2-8-2	284,400	Baldwin	55,200	552,000
Chicago, Rock Island & Pacific	15	2-10-2	383,000	American	78,673	1,180,085
	10	2-8-2	327,000	American	66,705	667,050
	10	4-8-2	340,000	American	70,103	701,030
Chicago, St. Paul, Minneapolis & Omaha	6	2-8-2	320,000	American	72,450	434,700
	4	0-6-0	164,000	American	46,400	185,600
Cleveland, Cincinnati, Chicago & St. Louis	10	0-8-0	217,000	Lima	47,559	475,592
	10	4-6-2	282,000	American	58,380	583,800
	50	2-8-2	328,000	American	68,040	3,401,968
Great Northern	45	2-8-2	320,000	Baldwin	51,111	2,750,000
Illinois Central	50	2-10-2	380,000	Lima	87,700	4,385,000
	25	4-6-2	278,000	American	64,925	1,623,125
Michigan Central	6	0-8-0	217,000	Lima	47,300	283,800
	10	4-6-2	282,000	American	58,340	584,000
	10	2-8-2	328,000	American	69,251	692,505
Minneapolis & St. Louis	15	2-8-2	262,000	American	64,365	965,475
New York Central	50	0-8-0	217,000	Lima	47,328	2,366,400
	20	4-6-2	282,000	American	58,440	1,166,800
	10	2-6-6-2	364,000	American	82,400	824,000
	3	0-8-8-0	468,000	American	92,000	276,000
Northern Pacific	6	2-8-8-2	476,000	American	101,964	611,785
	20	4-6-2	296,000	American	70,444	1,408,878
	25	2-8-2	335,000	American	73,370	1,834,215
	24	0-8-0	214,000	American	51,748	1,241,953
Southern Pacific	2	Electric	.....	Bald. West	42,500	85,000
Western Maryland	20	2-8-0	296,000	Baldwin	75,000	1,500,000

Freight Cars

Road	No.	Type	Capacity, lb.	Construction	Builder	Price Each	Price Total
Atchison, Topeka & Santa Fe	500	Gondola	100,000	St. fr.	Am. C. & F.	3,003	1,501,500
	1,250	Refrig.	80,000	St. unf.	Am. C. & F.	4,750	11,875,000
	1,250	Refrig.	80,000	St. unf.	Has. & Bar.		
Atlantic Coast Line	100	Phosphate	.....	St. unf.	.....	2,960	296,000
	500	Vent. Box	80,000	St. unf.	Std. Steel	3,718	1,859,090
	400	Hopper	100,000	Steel	Std. Steel	3,021	1,208,364
	100	Phosphate	.....	St. unf.	.....	3,324	332,466
Baltimore & Ohio	1,000	Box	80,000	St. unf.	Mt. Vernon	2,629	2,629,000
	1,200	Hopper	100,000	Steel	Pressed St.	1,919	2,302,800
	500	Refrig.	70,000	St. unf.	Am. C. & F.	2,800	1,400,000
Central of Georgia	100	Stock	.....	St. unf.	.....	2,500	250,000
	500	Vent. box	.....	St. unf.	.....	3,000	1,500,000
	200	Gondola	.....	St. fr.	.....	2,800	560,000
Chesapeake & Ohio	1,000	Gondola	200,000	Steel	500 Pr. St. 500 Std. St.	6,000	6,000,000
Chicago, Rock Island & Pacific	50	Caboose	.....	St. unf.	Std. Steel	4,464	223,200
	500	Gondola	.....	.....	Bettendorf	3,300	1,650,000
Chicago & North Western	500	Ore	100,000	Steel	Fullman	2,284	1,142,000
	500	Stock	80,000	St. unf.	Gen. American	2,605	1,302,500
	250	Refrig.	80,000	St. unf.	Am. C. & F.	4,872	1,218,000
	50	Caboose	.....	St. unf.	Am. C. & F.	4,112	205,600
Cleveland, Cincinnati, Chicago & St. Louis	500	Box	100,000	Steel	Std. Steel	3,662	1,830,760
	500	Auto	100,000	Steel	Has. & Bar.	3,722	1,860,760
	1,750	Hopper	110,000	Steel	Am. C. & F.	2,577	5,154,100
	250	Hopper	110,000	Steel	Std. Steel		
	100	S. d. Stock	80,000	St. unf.	Has. & Bar.	2,950	295,000
Great Northern	500	Ore	150,000	Steel	Am. C. & F.	2,540	2,540,000
	500	Ore	150,000	Steel	Has. & Bar.		
Illinois Central	1,000	Refrig.	60,000	St. unf.	Pullman	4,255	4,255,000
	200	Flat	100,000	Steel	Bettendorf	2,370	474,000
	300	Stock	80,000	St. fr.	Am. C. & F.	2,920	876,000
	50	Caboose	.....	.....	Freese & Swenson	3,000	150,000
Michigan Central	1,000	Auto	100,000	Steel	Am. C. & F.	3,722	3,721,520
	500	Hopper	110,000	Steel	Pressed Steel	2,577	1,288,675
	100	S. d. Stock	80,000	St. unf.	Has. & Bar.	2,950	295,000
	100	D. d. Stock	80,000	St. unf.	Has. & Bar.	3,125	312,500
	250	Refrig.	69,000	St. unf.	Mer. Des.	4,008	1,002,000
Minneapolis & St. Louis	500	Box	.....	.....	.....	3,000	1,500,000
	500	Gondola	.....	.....	.....	2,800	1,400,000
	200	Refrig.	.....	.....	.....	3,800	760,000
New York Central	1,000	Box	100,000	Steel	Std. Steel	3,660	3,660,000
	750	Auto	100,000	Steel	Am. C. & F.	3,720	3,720,000
	250	Auto	100,000	Steel	Std. Steel		
	1,500	Hopper	110,000	Steel	Std. Steel	2,443	3,664,000
	494	S. d. Stock	80,000	St. unf.	Mer. Des.	2,930	1,457,200
	200	D. d. Stock	80,000	St. unf.	Has. & Bar.	3,122	624,500
Northern Pacific	300	Hart. conv.	100,000	St. fr.	Am. C. & F.	3,745	1,123,374
	60	Air dump	.....	.....	.....	5,000	300,000
	100	Caboose	.....	St. center sills	Pac. Car. & Fdy.	3,500	350,000
	1,000	Box	.....	St. unf.	.....	2,500	2,500,000
Southern Pacific	2,000	Box	80,000	.....	Co. Shops	3,200	6,400,000
	1,000	Flat	100,000	.....	Co. Shops	2,400	2,400,000
	1,000	Stock	80,000	.....	Co. Shops	2,750	2,750,000
	500	Auto	100,000	.....	Std. Steel	3,310	1,655,000
	250	Ballast	100,000	.....	Mt. Vernon	3,682	920,500

Passenger Cars

Road	No.	Type	Construction	Builder	Price Each	Price Total
Atlantic Coast Line	25	Coaches	Steel	Pullman	$34,036	$850,905
Chicago & North Western	25	Coach	Steel	Am. C. & F.	26,771	669,275
	9	Smoking	Steel	Am. C. & F.	25,979	233,811
	2	Postal	Steel	Am. C. & F.	27,500	55,000
	23	Baggage	Steel	Am. C. & F.	22,000	506,000
	3	Mail and Baggage	Steel	Am. C. & F.	27,500	82,500
Illinois Central	20	Suburban	Steel	Pullman	29,880	597,600
	12	Compartment	Steel	Pullman	36,539	438,468
	18	Baggage	Steel	Pullman	26,650	479,700
	5	Dining	Steel	Fullman	51,005	255,025

is announced; the information, however, is not available before that action is announced.

The details given vary in nearly every case, depending upon conditions. In compiling the data given herewith, the information made available by the commission has been supplemented by details obtained from other sources. Thus in the usual instance the road shows the number of locomotives (or cars) involved, the type and the total cost of

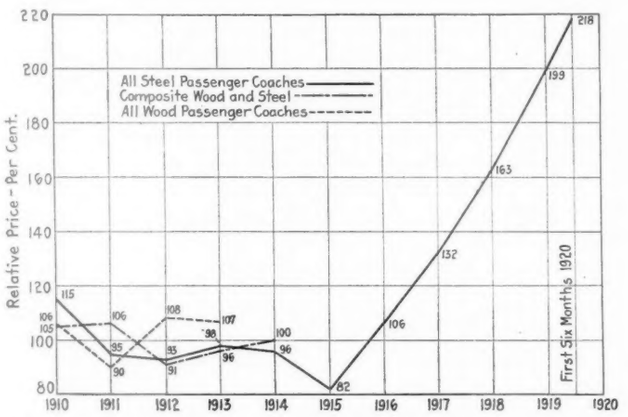


Fig. 3—Relative Prices of Passenger Coaches, 1910 to First Six Months of 1920 Shown in Terms of Average Prices 1910-1914 as 100

the equipment of that particular type. For instance, a road may indicate that it desires to finance the purchase of 10 Mikado locomotives at a total cost of $800,000, and 10 Pacific locomotives at a total cost of $680,000. From this it is evident that the Mikado locomotives will cost $80,000 each and the Pacifics $68,000 each. If the order has already been placed, this information has been supplemented from our own records with the name of the builder and the total weight in working order.

The data in the case of freight cars are similarly compiled, except that instead of total weight the details given relate to the capacity and class of construction. In the case of passenger cars the class of construction is given.

The feature concerning prices that is probably most important at the present moment is the trend of prices. It has been difficult to secure definite details as to the prices which have been paid for equipment ordered in the last month or two, one of the reasons being that details are not yet available for the public, the other and equally important reason being that so few orders have been placed. It is for this reason primarily that there are introduced in Table IV the relative prices of several basic iron and steel commodities which enter into car and locomotive manufacture. These prices have also been platted on a diagram, but, however they are shown, the rise to the peak in the early months of the year and the rapid decline in the latter months are plainly indicated. The prices of cars and locomotives presumably do not vary exactly with these commodity prices, but the lag behind them is not great. Investigation shows that car and locomotive prices have shown a decline in the last month or two. They are now approximately 10 per cent below the peak prices of the year.

TABLE IV—IRON AND STEEL PRICES

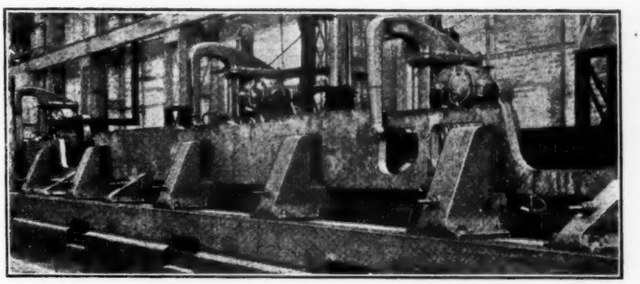
	Local No. 2 Foundry pig at Chicago, per gross ton	Bessemer steel billets at Pittsburgh, per gross ton	Soft steel bars at Pittsburgh, cents per lb.	Tank plates at Pittsburgh, cents per lb.
1910, January	19.00	27.50	1.50	1.55
July	16.56	25.00	1.45	1.41
1911, January	15.59	23.00	1.40	1.40
July	14.87	21.00	1.23	1.35
1912, January	14.00	20.00	1.15	1.15
July	14.70	21.50	1.25	1.30
1913, January	17.90	28.30	1.70	1.75
July	14.70	26.60	1.50	1.45
1914, January	13.75	20.13	1.20	1.20
July	13.75	19.00	1.12	1.10
1915, January	13.00	19.25	1.10	1.10
July	13.00	21.38	1.25	1.22
1916, January	18.50	32.00	2.03	2.25
July	19.00	41.00	2.63	3.44
1917, January	30.00	63.00	3.15	4.45
July	55.00	100.00	4.50	9.00
1918, January	33.00	47.50	2.90	3.25
July	33.00	47.50	2.90	3.25
1919, January	31.00	43.50	2.70	3.00
July	26.75	38.50	2.35	2.65
1920, January	40.00	48.00	2.75	2.72
February	42.25	55.25	3.00	3.50
March	43.00	60.00	3.63	3.63
April	43.00	60.00	3.75	3.75
May	43.00	60.00	3.63	3.75
June	43.40	61.00	3.50	3.55
July	45.25	62.50	3.50	3.38
August	46.00	61.00	3.25	3.25
September	46.00	58.74	3.25	3.25
October	44.50	55.00	3.13	3.09
November	39.40	49.70	2.87	2.81
December	34.50	43.50	2.35	2.65

Three Column Frame Milling Machine*

In Germany many locomotive frames are now made from plates, the full width of the frame section, rolled in armor plate mills. The recesses are cut out either by the oxy-acetylene torch or by machining. After cutting out with the torch, the frames are finished on the familiar type of slotting or milling machine.

The autogenous cutting process, however, is expensive and changes the quality of the material in proximity to the cut. For these reasons a firm of German machine tool builders has designed the interesting three column milling machine illustrated. The locomotive frames are clamped to heavy angle blocks rigidly fastened to the foundation shown. Suitable webs are cast to the angle blocks so that they are not in the way of the mechanic during the work and do not need to be shifted in the course of the operation.

Three milling columns are provided, entirely independent of each other and moving on common ways. Each has a horizontal milling spindle. Levers and hand wheels for the operation and control of the machine are arranged so that the entire machine may be conveniently operated from one central platform.



Three-Column Frame Milling Machine

Below the frame to be finished there is a templet which in the natural size shows the shape of the section to be milled. A copying roller fastened to the slide rest of the milling machine runs in the slot of the templet. The vertical and transverse feeds of the column and the slide rest with the milling cutters are thus mechanically controlled by the copying roller. For introducing the milling cutter into the frame recesses, the machine itself is arranged to drill the necessary holes.

The milling cutters are permanently cooled by water which returns to a water tank provided in the concrete foundation of the machine, a perforated sheet iron plate retaining all chips. The machine is stated to be capable of accurate work and high production.

*Abstract from an article in the December issue of Engineering Progress, entitled Milling Machine for Locomotive Frames.

Increasing the Capacity of Old Locomotives*

Suggestions for Modernizing Old Locomotives and the Possibilities of This Development

BY C. B. SMITH
Mechanical Engineer, Boston and Maine

IN these days of the high cost of railroading, responsible officers of the mechanical departments realize that the necessity for reducing the cost of all locomotive operation and maintenance is more urgent than ever. Such saving can be accomplished in two ways, one by using new and modern locomotives, the other by rebuilding old types.

On the majority of our roads there are still locomotives of the earlier modern types whose general features of construction are satisfactory, and which only require modernizing to make them economical transportation units. Improvements for such classes of locomotives may include, in addition to superheaters, piston valves in place of slide valves, outside valve gears in place of Stephenson motion, and such other improvements as are usually made upon engines at general shoppings.

When setting out to rebuild a locomotive the experienced supervisor appreciates the opportunity to apply many devices and facilities which will standardize the engine in accordance with the railroad company's practice, and in so doing, reduce repairs and stores department expense in maintenance.

The aggregate of such improvements results in a locomotive which in proportion to its capacity will produce service results comparable with those of entirely modern construction, and at a cost approximately one-half that for a new locomotive of similar capacity. The difficulty in carrying forward an extensive reconstruction program, however, is in finding the shop facilities either on the railroad or among the locomotive builders in order to advance the work at a satisfactory rate of progress. Despite this difficulty the results which could be obtained from the operation of reconstructed locomotives, if they could all be rebuilt within the next few years, would justify a special effort on the part of railroad managements to bring it about.

On roads where the number of old locomotives which warrant rebuilding is sufficient to require a period of more than three years to complete the work, it would seem necessary to arrange for enlargement of shop facilities in order to hasten the reconstruction. If, however, adequate shopping facilities are not forthcoming, the improvement program for locomotives must be confined chiefly to the application of superheaters and the substitution of piston for slide valves; together with the minor but relatively important betterments that may usually be applied at the shopping period. On some roads this work alone will require six years at the present rate to equip what can rightly be called the "early-modern" locomotives.

Some of the engines built within the past ten years have developed weaknesses in frames and in parts of running gear. It has proved justifiable to reconstruct them by substituting new parts of stronger design and thus avoid recurring breakages which interrupt both the road service of these engines and the repairs to others. On roads whose traffic and service conditions now demand and will continue to demand the use of light locomotives for passenger trains and freight trains on branch lines, the better classes of the light locomotives should also receive their share of improvements along with the heavier power.

Old locomotives requiring new boilers have very generally been scrapped, but where light train service demands no heavier engines than formerly, the writer believes it advisable to rebuild such engines with radial-stay boilers, superheaters, new piston-valve cylinders, main frames when necessary, and outside valve gears. If there is to be no increase in the boiler pressure over that formerly carried by the locomotive and the valve motion has given little trouble by breakages, the Stephenson motion may be connected to the piston valves through the usual rocker-shaft connections.

When rebuilding locomotives there is a favorable opportunity for replacing old tenders as well, transferring the latter to older locomotives for spare use or as substitutes for damaged equipment. When the condition of old steel tender frames requires that they be replaced, the one-piece steel casting and a larger-capacity tank should be used, as both will reduce future expense in repairs. The success of autogenous welding eliminates any objections to the use of large steel castings for fear of breakages.

Tanks should be reconstructed in coal space to permit gravity delivery of the greatest amount of fuel that is possible at the coal gates within reach of the fireman's shovel. Application of power-operated coal pushers should be made to tanks where alterations for the gravity delivery of coal cannot be satisfactorily made and where the service conditions will show a saving in expense by its use over hand methods of shoveling forward coal while on the road or at short lay-over stations.

Discussion

The discussion following the presentation of this paper at the recent meeting of the Railroad Section of the American Society of Mechanical Engineers was unusually broad and comprehensive. Through the efforts of the committee on meetings and papers, some of the best authorities on this subject had been engaged to participate in this discussion. The first to speak in regard to increasing the capacity of old locomotives was Frank McManamy, now assistant director-general of railroads. Without going into all of the details relating to those features essential to increasing the capacity of old locomotives, Mr. McManamy outlined some of the conditions essential to the successful modernization of power. It was pointed out that the value of any specialty applied for the purpose of increasing the capacity of old locomotives would be nullified unless the railroads possess a trained organization and adequate facilities for the proper maintenance of these appliances. The application of such appliances was strongly endorsed by Mr. McManamy, who claimed the credit for the liberal modernization program undertaken during the period of federal control.

The application of the superheater, the stoker and the feedwater heater were commented upon as among the best measures toward modernization, but with the application of these, as with other devices, intelligent handling and adequate maintenance are essential before they can be of any real value. The simple application of these devices is not sufficient; they must be properly used and adequately maintained. In view of this fact Mr. McManamy believes that the improved locomotive terminal is, in fact, the key to the

*Abstract of a paper presented at the Railroad Section of The American Society of Mechanical Engineers on December 8, 1920.

situation. So many complicated specialties are now being applied to locomotives that it is now common to refer to these locomotives as being "full-jewelled," and in many instances the application of these specialties has proved a detriment because the railroads did not have adequate terminal facilities to insure their maintenance.

In a written discussion of the subject submitted by W. O. Moody, mechanical engineer of the Illinois Central, the necessity for adequate shop, as well as locomotive terminal facilities, was emphasized. Mr. Moody pointed to the fact that in the absence of shop facilities adequate for current maintenance of locomotives, little could be hoped for toward the modernization of locomotives upon any considerable scale. In this connection it should be remarked that the locomotive companies which, until recently, have been busily engaged on new locomotive construction, are now in a position to undertake considerable modernization work for the railroads, and in view of the possibilities in this direction it would appear to be an opportune time for the railroads to assign some of this work to the locomotive builders, where they are unable to undertake it in their own shops and are not justified in the purchase of new locomotives.

Mr. Moody spoke of the locomotive booster as one of the most promising appliances designed to increase the capacity of old locomotives. It is believed that any comprehensive plan of modernization should include consideration of the booster. It was also pointed out that the modernization of locomotives offered an excellent opportunity for the further standardization of parts to such an extent as would permit a considerable reduction in the number of parts that must be carried in stock to protect the locomotives in service. Any reduction of this character should be welcomed as a means for reducing overhead charges.

J. C. Hassett, mechanical engineer of the New York, New Haven & Hartford, also advocated the modernization of old locomotives as a means to increase their capacity and laid particular stress upon the necessity for strengthening locomotive frames in connection with this development. Some interesting facts in connection with this work as undertaken on the New Haven were described by Mr. Hassett, who said that it had been found necessary to materially strengthen the frames of certain locomotives before they could be modernized and that this had also resulted in improving their riding qualities as well as increasing their capacity.

Forceful Arguments for Feed Water Heating

Some strong arguments in favor of locomotive feed water heating were presented by E. A. Averill, vice-president of the Locomotive Feed Water Heater Company, who contributed to the discussion as follows:

"Increasing the capacity of all old or semi-modern locomotives, whenever increased capacity can be used and increasing the efficiency of those which are in a service where increased capacity will not show a return, should be the first feature to be investigated and carefully analyzed.

"You will be astonished at the returns that can be obtained in investments made to this end. As an example of what can be accomplished on even some of the more modern locomotives, built within the last six or eight years, let me quote the results recently obtained from road tests with a locomotive feed water heater which is one of the appliances mentioned in this paper. These tests were made on three different railroads and each was as carefully conducted as is possible with tests made in regular operation. On the first road, the test showed a saving, due entirely to the appliance being investigated, of $252 a month, based on coal costing $5 a ton. On the second road, the direct saving was $233 a month, and on the third it was $226 a month. This is an average for the three roads of $237 saved per month per locomotive.

"Do you not think that a net saving of over $200 a month from each locomotive will make a welcome addition to the net operating income of any railroad? The feed water heater is applicable to all kinds and classes of locomotives at a moderate expense and offers one of the quickest and most positive methods by which the capacity of a locomotive can be largely increased. It has the further advantage of not requiring any additional shop facilities for its extensive application. From the standpoint of the motive power department doing its full share towards making visible the net profits of a railroad, I would recommend a thorough study of feed water heating to be placed near the top of the list of things to be considered.

"It may interest you to know that feed water heaters, which will raise the temperature of the water from 40 deg. or 50 deg. to from 230 deg. to 250 deg., have been in successful railroad service for over three years. Furthermore, these heaters filter all the water formed from the condensed exhaust steam and return it, free from oil, to the tender. This adds about 14 per cent to the capacity of the tender and greatly extends the distance that can be made between stops for water.

"On most locomotives an increased boiler capacity can be fully used in regular service and furthermore since any boiler is most economical and most efficient at its lower rates of working, an appliance which makes the boiler larger always shows returns. It gives the increased capacity when it is needed and it gives greater efficiency when the larger capacity cannot be used. A feed water heater lies entirely in this class of equipment. It permits the boiler to deliver 9 lb. of steam for each pound of coal burned where, without the heater, it would deliver about 7.8 lb. of steam for each pound of coal. If, however, service conditions were such that only the smaller quantity of steam could be employed, a boiler equipped with a feed water heater would be operating at 65 per cent efficiency, as compared with 61 per cent for the same quantity of steam, without the heater, and thus this appliance is giving a return of one sort or another at all times.

"I have mentioned the fact that there is a return to the tender of 14 per cent of distilled and filtered water, and inasmuch as any study of increased locomotive capacity must be based on a consideration of the locomotive as a producer of economical transportation, this feature, many times, is found to be one of great importance. The ability to continue the train in operation past a water station, where it would have been compelled to stop if not equipped with a feed water heater, frequently means a difference of hours in the arrival of the train at the terminal and a very large saving of overtime wages and loss of service of the locomotive. Again this feature at periods of congested traffic frequently permits the despatcher to keep everything moving on the division and opens up the possibility of very large returns from this cause alone. Where feed water heaters have been applied to locomotives, it is almost universal that the train despatcher is one of the strongest advocates of a heater on an engine."

Superheat as a Means to Increased Capacity

In commenting on the subject of increasing the capacity of old locomotives, H. B. Oatley, chief engineer of the Locomotive Superheater Company, took this opportunity of bringing out, somewhat in detail, the features which have prompted the very extensive superheating programs which have been in vogue on many of the railroads for a considerable period. A table presented by Mr. Oatley gave some comparisons between saturated and superheated locomotives. The locomotives considered were typical of each class. The cylinders, boiler pressure and maximum tractive power were shown as being the same for both the saturated and super-

heated steam conditions, although many engines have had the tractive power increased when superheaters were applied, under the conditions referred to later.

"By the addition of a high degree superheater," Mr. Oatley said, "it has been demonstrated that the steam consumption per horsepower hour is reduced about 28 per cent. The figures commonly accepted as representing good practice are 27 lb. for saturated steam and 19.5 lb. for superheated steam. In the case of the 0-6-0 type boiler, the horsepower has been increased 15 per cent; for the 4-4-0 type 14 per cent; for the 2-6-0 type 13 per cent; for the 2-8-0 type 10 per cent, and for the 4-4-2 type 10.2 per cent. The maximum cylinder horsepower, using the American Locomotive Company's figures, has, by the addition of a superheater, been increased about 8 per cent.

"The ratio between boiler horsepower and cylinder horsepower, therefore, has been improved. When consideration is also given to the fact that a boiler with a superheater is at a greater advantage when worked under high rates of evaporation, for the reason that the degree of superheat increases under such conditions, the marked improvement is evident. It is very clear that the additional boiler capacity afforded by the addition of the superheater should, if possible, be utilized by providing greater maximum tractive power. if possible, cylinder patterns which are in use on other classes of engines on the road. It is many times found that a cylinder diameter can thus be selected which will give the desired increase in tractive power, even with a decreased boiler pressure. A decrease in boiler pressure in very many instances, particularly on the older boilers, is especially attractive, as such boilers are frequently of an age and condition which would in any event require either scrapping or operating at a lower pressure.

"Many instances will be found where for one or another of the conditions already mentioned, an increase of cylinder diameter above that which is obtainable by boring will not be advisable, and if, in such cases, slide valves are existent on the engine in question, the application of superheaters need not be foregone, as the use of piston valve steam chests fitted to existing slide valve seats has demonstrated its practicability and economy."

A Critical View of the Situation

In his remarks on the subject of increasing the capacity of old locomotives, J. T. Anthony, vice-president of the American Arch Company, stated that with 65,000 locomotives in service on American railroads, only 35,000 are equipped with superheaters; 43,000 with arches; 37,000 with

COMPARISON OF SATURATED AND SUPERHEATED STEAM LOCOMOTIVES OF VARIOUS TYPES

Line		4-4-0		4-4-2		2-6-0		0-6-0		2-8-0	
		Sat.	S.H.	Sat.	S.H.	Sat.	S.H.	Sat.	S.H.	Sat.	S.H.
1	Cylinders	20" x 24"		22" x 26"		19" x 26"		20" x 26"		21" x 30"	
2	Wheel diameter (drivers)	69"		80"		63"		51"		63"	
3	Boiler Pressure	190#		205#		200#		180#		210#	
4	Tractive Power (maximum lb.	22470		27470		25300		31100		37500	
5	Weight on Drivers, lb.	94000	96000	124100	126000	125500	128000	144600	147600	172500	176500
6	Factor of Adhesion	4.18	4.27	4.51	4.59	4.96	5.06	4.65	4.74	4.6	4.7
7	Heating surface, tubes sq.ft.	1957	1035	2474	1335	1732	948	1750	987	3194	1737
8	Heating surfaces, flues " "	-	402	-	506	-	392	-	412	-	650
9	Htg.surf.firebox & water tubes sq.ft.	232	232	166	166	158	158	156	156	189	189
10	Total " "	2189	1669	2640	2007	1890	1498	1906	1555	3383	2576
11	Superheating Surface " "	-	314	-	435	-	296	-	306	-	530
12	Combined Total " "	2189	1983	2640	2442	1890	1794	1906	1861	3383	3106
13	Total Water Evaporated (1) Lb.	31530	25930	32228	25728	26720	22120	28430	23610	40960	32510
14	Steam per ind. h.p. hour Lb.	27	19.5	27	19.5	27	19.5	27	19.5	27	19.5
15	Boiler Horse Power	1165	1330	1196	1320	999	1135	1052	1210	1515	1667
16	Boiler H.P. Increase %	-	14	-	10.2	-	13	-	15	-	10
17	Maximum Cylinder Horsepower (2)	1265	1369	1655	1786	1202	1300	1199	1297	1543	1667
18	% Boiler H.P. of Cylinder H.P.	92.3	97.5	72.3	74	82.9	87.4	87.7	93.2	98.1	100

(1) American Locomotive Co.'s method used but figures are those used by Locomotive Superheater Co.
(2) American Locomotive Co.'s figures used.

When considering existing locomotives the increase in the maximum tractive power requires consideration of, 1st. The factor of adhesion. 2nd. The strength of the running gear which has to withstand the thrust of the piston.

"As in all other problems, the cost of making improvements must be balanced against the advantages which can be realized. For example: if the engine at the present time has adequate power for the work which is to be done, the expense in providing additional power would not be justified. Such cases are, however, believed to be rare, as the very large majority of existing locomotives are for all or a part of their working time required to handle every ton behind the tender that they will move. If the factor of adhesion and the strength of the parts taking piston thrust are such that an increase in cylinder tractive power can be utilized, such additional power may be attained by, 1st. Increasing boiler pressure. 2nd. Increasing cylinder diameter.

"If the amount that the maximum tractive power can be increased effectively is greater than can be obtained by boring existing cylinders, or by increasing boiler pressure, or a combination of the two, the use of new cylinders should be carefully considered. If new cylinders are applied a cylinder diameter should be selected which would permit the utilization of pistons, cylinder heads, steam chest covers, etc., and, automatic fire doors; 15,000 with power reverse gears; 2,000 with automatic driving box wedges, and only 30 with feed water heaters. The reasons commonly given for this condition, he said, "are lack of shop facilities and inability to get appropriations with which to carry on the work. But it is difficult to understand why the responsible officials who willingly make appropriations of millions of dollars for grade reductions, curve eliminations, etc., with the sole idea of increasing train loading and reducing operating expenses, should turn a deaf ear to the requests of the mechanical departments when they have the same object in view.

"The railway shop equipment is woefully inadequate at the present time; but this will not serve as an excuse for the fact that 22,000 locomotives are being operated today without brick arches. This simple device can be installed in the round-house in less than 24 hours, and its maintenance not only does not require any increase of the round-house force; but effects a reduction in boiler repairs and engine failures. Many years of use and a large number of carefully conducted tests have shown conclusively that the arch is good for a fuel saving of 7 to 14 per cent, or for an increase in boiler capacity of 8 to 16 per cent. To use a conservative figure the arch is good for an average reduction in fuel consumption of 10 per cent, or an increase in boiler capacity of 11

per cent. Under the present condition of high price of fuel each dollar invested in the brick arch for old locomotives is equivalent to at least a five dollar reduction in operating expenses.

"There are only three methods of increasing the heating surface of an existing firebox, i. e., by the installation of a combustion chamber, or arch tube, or thermic syphons. At the present time there are only 6,000 locomotives equipped with combustion chambers, and something over 100 equipped with thermic syphons, this device being of rather recent origin. Many of the existing boilers can be improved by adding combustion chambers when new fireboxes are put in, thereby increasing the firebox volume and reducing the oft-time excessive flue lengths, and in other cases new back-ends should be put on when it is necessary to renew fireboxes of narrow and antiquated designs, thereby increasing the grate area and firebox volume. Too little attention has been paid to the possibility of improvements in old boilers by these means. While it is true that the addition of superheaters and brick arches often reduces the demands made upon it, there is still a lot of room for improvement, particularly in regard to the firebox as a furnace wherein fuel may be burned efficiently. In this connection, we might call attention to the poor designs of ash-pan on thousands of our present locomotives, on many of which it is impossible to secure an adequate air supply. Such conditions can be remedied at comparatively little expense and effect a large saving in fuel.

"As a tip to the skeptics who are prone to wait for someone else to demonstrate that improvements are possible, I quote the following figures obtained from tests of Consolidation locomotives on a large western road where the operating conditions were such that the locomotives made 40,000 engine miles per year; the cost of coal being $4.50 per ton on tender, which is much below the average price at the present time.

	Annual fuel consumption per locomotive		Annual saving	
	Tons			
Saturated Consolidation without arch	7,500	$33,750	.....	
Saturated Consolidation with arch	6,752	30,384	$3,366	(Saving credited to brick arch)
Superheated Consolidation with arch	4,989	22,450	7,934	(Saving credited to superheater)
Superheated Consolidation with arch and syphons	4,257	19,156	3,294	(Saving credited to thermic syphon)

"The addition of the three devices mentioned resulted in an annual saving of $14,594 per locomotive; this 44 per cent reduction in the fuel cost being accompanied by an increase of approximately 20 per cent in tonnage hauled. And this does not represent the limit to improvements, for there are other devices that might be added, and changes made that would result in still further improvements.

"In the last paragraph of his paper Mr. Smith voices the hope that the discussion at this meeting will result in outlining some practical action to be taken by the various roads to hasten the work of reconstructing old locomotives, and states that the application of all desirable auxiliaries is prohibitive without radical provision for the carrying out of such a program. We join him in that fond hope, but, in our opinion, it will be necessary to first bring about a radical change in the attitude of many railway officials before any adequate provisions for such a program can or will be made.

"The many improvements that have been made in locomotive design in the past 10 or 15 years have not come about in answer to any loud and sustained cry from the railroads for more efficient locomotives. The railroads asked for larger and more powerful locomotives; but the devices that have made the locomotives of increased capacity and efficiency possible, have been largely left to the ingenuity of the railway supply companies and, in a smaller degree, to the locomotive builders. The development of the several well-known fuel economy and capacity increasing devices has been due to the labor and efforts of men who have left the railway service, in many cases on account of the lack of interest of the railroad in the device which the individual was trying to get perfected and used.

"If we can judge the future by the past, there will be no radical provisions made for the carrying out of a locomotive reconstruction program until the officials of the mechanical and operating departments awake to a full realization of the possibilities of reducing present operating expenses by the maintenance of a high standard of efficiency of *all* their locomotives, and by their urgent demands and intelligent presentation of facts, convince the higher authorities—those who have to dig up the money—of the feasibility and desirability of such a program."

The Care of Locomotive Boilers

Some interesting observations on the care of locomotive boilers are found in a paper on Locomotive Running Shed Practice by W. G. Bishop of the South African Railways, published in the Journal of the Institute of Transport. In discussing methods of washing out engines, Mr. Bishop says "The old method of washing out boilers with cold water is so well known that its disadvantages make one surprised at the tenacity displayed in the retention of such an obsolete method. As a time and money wasting process, it would be hard to beat. To wash out a boiler with cold water will take 12 hours at least to do properly and there is always the added danger that transportation calls are so pressing, that boilers are not allowed to cool properly before cold water is admitted. This is extremely detrimental to the life of the firebox."

Mr. Bishop estimates that in a terminal handling 100 locomotives in a fair water district, the hot water washout plant would effect a saving of 3,600 engine hours each month. There is a material saving in the cost of labor for washing in using hot water and the hot water system also effects additional savings in labor and material for repairs to boilers, in fuel used for firing up and in water. In conclusion, Mr. Bishop says, "Washing out with cold water is as obsolete as the tallow candle and no railroad concerned in the movement of traffic can afford to hang up its power by continuing to use cold washouts. It is a clear loss of 20 per cent of its power at least."

Much of the water used for boiler purposes in South Africa is of very bad quality and apparently the South African Railways have experienced the same difficulties as American roads in applying water treatment, for Mr. Bishop remarks, "Very few railways ever give any system of water treatment a chance. It is the job of a highly skilled specialist, the railway chemist. Too often plants installed are looked after in some sort of manner by a mechanical officer who may make chemistry a hobby and fairly successful results are obtained. A change comes and a new man arrives who does not specialize in chemistry and the water softener falls in disuse and finally goes out of action. A large corporation should have a chemist on its staff and water treatment should be considered of the highest importance. No softening plant or boiler compound will ever be a success until it is handled on the proper lines. The effect of good water on the life of the boilers and freedom from leaks and repairs is so great that one often wonders how any road can afford to be without its water treatment section, officered by a fully qualified, analytical chemist."

IN QUENCHING TOOLS be careful to have no sharp line of demarcation between the hardened and softer unquenched sections.—*The Melting Pot.*

Reducing the Fuel Consumption of Power Plants

Methods of Increasing Boiler Efficiency; Reducing Heat Losses by Insulating Steam Pipes

BY WILLIAM N. ALLMAN

THE matter of fuel conservation is now one of the big problems of the day. Coal prices have soared and costs are considerably more than just a few years ago. It is therefore evident that the power plant engineer has to confront problems that are reaching immense proportions. In summing up the whole matter the remedy for fuel waste resolves itself into a thorough knowledge of combustion and the initiative to apply such knowledge in such a way that results will be obtained. From this it is quite evident that trained men are desired to meet the requirements of economical operation.

To waste coal is to waste money and unless all possible heat units are being obtained from the coal a part is being wasted. What goes up the chimney as smoke and what coal is thrown away in ashes is absolutely lost. If this were unavoidable it could properly be called waste, but this is not altogether unavoidable and through proper methods may be saved to a large degree.

There are now available a great many fuel saving devices which should be considered by power plant operators, as the saving in fuel in a great majority of cases more than pays for their installation in a short time. Such devices as superheaters, feedwater heaters, stokers, feedwater regulators, fuel economizers, air and steam flow meters, water treating devices, etc., should receive careful attention, and a thorough study in order to determine their value.

Dr. Charles P. Steinmetz has also made the statement that he considers it hopeless to anticipate much improvement in the burning of coal and coke, and on an average we get barely more than 10 per cent of the value of the coal for power, the remainder going off as heat. The only solution is to use the carbonized fuel from the oven in such a way as to get out of it both the power and the heat. It is then a very important matter to give undivided attention to the conservation of the heat, and the biggest factor in this regard is proper insulation of exposed parts.

Another important phase is to make use of all exhaust steam (this represents heat) for heating buildings, drying materials, operating low pressure turbines, etc.

The power plant engineer who is wide awake is having his attention drawn very forcibly to the importance of strict conservation, as there have been endless circulars issued by the government, state and municipal authorities as well as numerous articles in the leading technical journals and with all this vast amount of literature emphasizing economy there is no excuse for undue waste. It is necessary, of course, to consider thoroughly conditions in the individual plant, for instance possible economies with superheat depend upon how far the plant has already been developed along lines of thrift. The only way to adequately judge the worth of superheating in any plant is to consider the economies made possible by its use, the first cost, maintenance cost and the simplicity of its installation. It has been claimed that it is possible to save as high as 15 per cent of fuel; in such cases the superheater would soon pay for its installation. This same application can be made to other appliances, and the merit of each should be studied and considered from all angles.

Efficiency versus Losses

The term "efficiency" when applied to a furnace means the combined efficiency of the boiler and furnace, this for the reason that losses are attributed to the complete apparatus.

The highest efficiencies that have been obtained with coal vary from about 82 per cent to 85 per cent. Loss of efficiency is therefore a direct waste of fuel, and failure to obtain full efficiency and capacity from a plant may result from:

Inleakage of air through boiler settings.
Improper methods of firing or draft control.
Insufficient draft.
Unsuitable fuel.
Unequal division of load between the several boilers.
Formation of scale and corrosion on heating surfaces.
Low temperatures of feed water.
Waste of exhaust steam.
Heat absorbed by boiler.
Improper or insufficient insulation.
Incomplete combustion of carbon.
Heat carried away in dry chimney gases.

The results of numerous tests indicate that a content of 10 per cent to 13 per cent CO_2 (carbon dioxide) should be obtained, and this would be considered good performance. Large excess of air is indicated by low CO_2 content and high-oxygen content, incomplete combustion being indicated by CO (carbon monoxide), which should be low in percentage. As a general rule the CO content in the flue gases should not be allowed to reach one-half of one per cent. Causes that may be assigned to excess of air, are: Holes in the fire, too large openings in the dampers of the firing door, badly warped fire doors preventing them from closing tightly, too frequent raking or slicing of the fire, leaky settings, fire doors being kept open too long.

It is quite possible to have the gases running as high as 14 per cent in CO_2 without a trace of CO, while in other cases a considerable amount of CO may obtain even with CO_2 running at 10 per cent. It should also be borne in mind that CO is only one of the combustible gases, and the actual loss from incomplete combustion may be twice as large as that indicated by the percentage of CO as there may be present H_2 (hydrogen) and in some instances a trace of CH_4 (methane).

Causes for Excess Air and Fuel Waste

One of the most common causes for excess air in flue gases is holes in the fire bed. This can be avoided through frequent firing and placing coal on the thin spots. It is highly important that the fireman understand combustion in order to get the maximum efficiency out of coal. He should keep in mind that it is his duty to make steam economically and not merely burn coal. He should not become discouraged if he finds it difficult to understand the principles of furnace efficiency, as there is no such thing as a royal road to knowledge, and it is quite necessary that the whole matter of combustion be carefully analyzed. Co-operation is also a big factor in the success of the plant and successful firemen and engineers do not overlook this very important matter.

To prevent waste of fuel it is necessary to see that all settings are tight in order to eliminate the infiltration of air. This is one of the largest single items of loss in the whole cycle of power production, and also one of the most common in its occurrence.

There are three important places to investigate for this air leakage:

1. Cracks in boiler walls and settings.
2. Leaks or air spaces between iron door frames and boiler walls.
3. Leaks around blow-off piping.

Cold air that leaks in absorbs heat until it reaches the temperature of the furnace gases, and hence wastes heat that would otherwise perform useful work. It is conservative to estimate on the following basis: if air leakage through boiler walls amounts to only 5 per cent of the actual quantity of air required for proper combustion and high efficiency, 1 per cent of the fuel burned is wasted. Leakage often amounts to more than 100 per cent and 100 per cent leakage causes fuel wastage of at least 20 per cent.

Cracks in the boiler walls may not be very apparent, yet may allow leakage enough to materially lower the efficiency of the boiler. Air leakage is easy to detect. A simple method is to take a sheet of paper about two feet square and cut out in the center a round hole about one inch in diameter. This sheet should be pasted on a square wooden frame made of four pieces of inch by inch stock. The frame should be held against the boiler wall with the paper side out, making the joints between frame and wall tight by using putty or fire clay. Then by holding a match or a candle in front of the hole, leakage through the four square feet of boiler-wall surface creates a draft through the one-inch hole in the paper. The amount of this draft is indicated by the sucking-in of the flame, and is usually quite surprising. To conduct this test successfully, it is essential that all joints between the frame and boiler wall be made air-tight.

Although air leakage is one of the most important causes of fuel waste, it is nevertheless one of the simplest to remedy. The application of a suitable insulation in sheet or block form and of proper thickness, finished with a smooth, tight surface not only prevents the infiltration of air but also reduces radiation or loss of heat from boiler walls. This remedy should always be used if boiler walls are hot and loss due to radiation correspondingly great.

Boiler walls may be made air-tight by applying to the outside of the wall a coating of material which will seal up cracks and which is itself sufficiently elastic to permit expansion and contraction without cracking. Wide or large cracks can easily be taken care of by caulking with material such as asbestos wick before the application of a coating as referred to above.

Open spaces around access and other door frames should be thoroughly sealed by means of a cement that will adhere to both iron and the brickwork and that will remain intact when subjected to heat and resulting expansion and contraction. Defective brickwork settings should be constantly repaired and the bricks should also be bonded together with a material which will not readily crumble or fuse away and which is capable of resisting heat and expansion strains. Additional protection to fire-brick settings may also be obtained by coating the interior surface with a refractory material.

Proper Amount of CO_2 (Carbon Dioxide)

A careful check should be made constantly in order to ascertain the percentage of CO_2 and particular care should be taken to see that this does not get too low. When it is found that the percentage of CO_2 runs below about 10 per cent it is time to study the conditions carefully and learn the cause, as it is certain that there is loss and waste of heat, which means loss in dollars and cents. It should also be understood that a definite percentage of CO_2 does not always indicate a certain efficiency, because it is quite possible to obtain a 10 per cent content of CO_2 with a certain efficiency while it is also possible with the same efficiency to show a 13 per cent content of CO_2.

The percentage of CO_2 indicates the volume of excess air flowing through the furnace and the boiler passes, or the ratio of the air that is taken in for the purpose of consuming the coal and that which is taken in and results in a wasteful cooling of the furnace gases. To burn one pound of coal requires about 14 lb. of air. This air enters the furnace at atmospheric temperature and leaves at a temperature of 500 deg. F. or more. During this transition it carries with it all the heat it has absorbed in being heated through this range of temperature. For each degree of temperature rise one pound of air absorbs approximately one-fourth of a heat

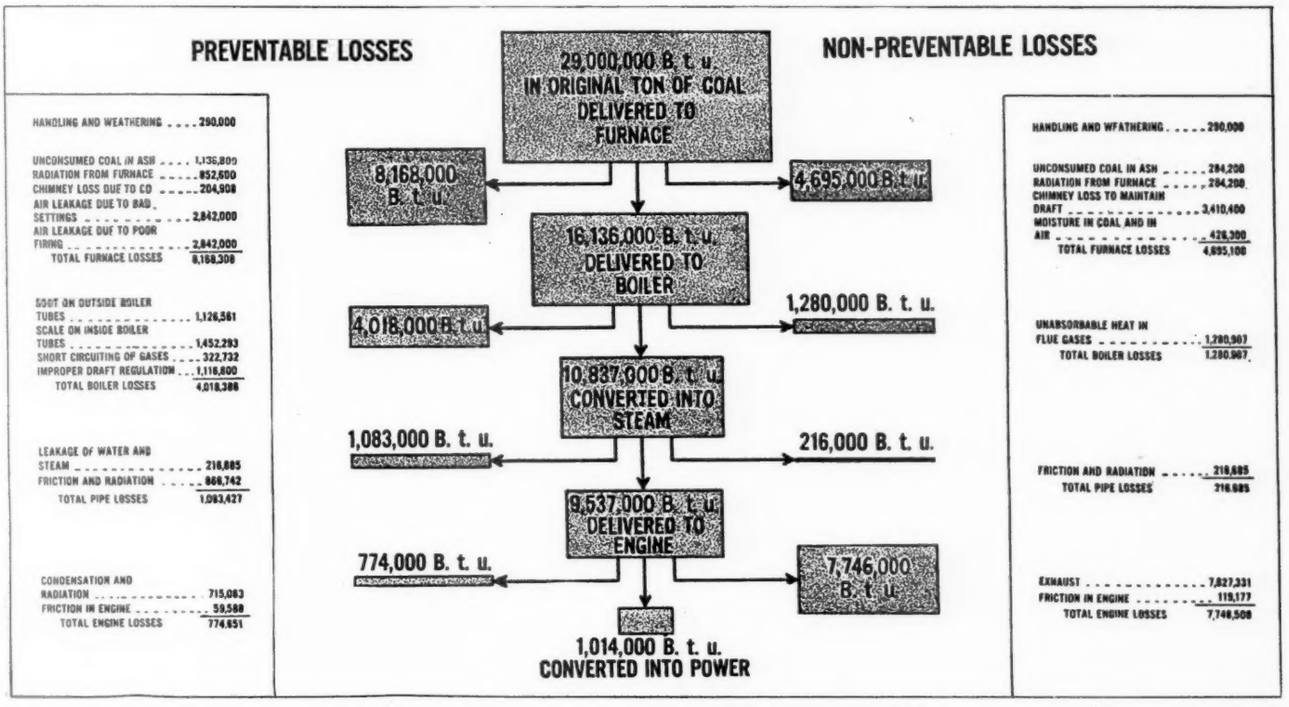

PREVENTABLE LOSSES
NON-PREVENTABLE LOSSES
29,000,000 B. t. u. IN ORIGINAL TON OF COAL DELIVERED TO FURNACE
8,168,000 B. t. u.
4,695,000 B. t. u.
16,136,000 B. t. u. DELIVERED TO BOILER
4,018,000 B. t. u.
1,280,000 B. t. u.
10,837,000 B. t. u. CONVERTED INTO STEAM
1,083,000 B. t. u.
216,000 B. t. u.
9,537,000 B. t. u. DELIVERED TO ENGINE
774,000 B. t. u.
7,746,000 B. t. u.
1,014,000 B. t. u. CONVERTED INTO POWER
HANDLING AND WEATHERING 290,000
UNCONSUMED COAL IN ASH 1,136,809
RADIATION FROM FURNACE 852,600
CHIMNEY LOSS DUE TO CO 204,908
AIR LEAKAGE DUE TO BAD SETTINGS 2,842,000
AIR LEAKAGE DUE TO POOR FIRING 2,842,000
TOTAL FURNACE LOSSES 8,168,308
SOOT ON OUTSIDE BOILER TUBES 1,126,561
SCALE ON INSIDE BOILER TUBES 1,452,293
SHORT CIRCUITING OF GASES 322,732
IMPROPER DRAFT REGULATION 1,116,800
TOTAL BOILER LOSSES 4,018,386
LEAKAGE OF WATER AND STEAM 216,885
FRICTION AND RADIATION 866,742
TOTAL PIPE LOSSES 1,083,627
CONDENSATION AND RADIATION 715,083
FRICTION IN ENGINE 59,588
TOTAL ENGINE LOSSES 774,651
HANDLING AND WEATHERING 290,000
UNCONSUMED COAL IN ASH 284,200
RADIATION FROM FURNACE 284,200
CHIMNEY LOSS TO MAINTAIN DRAFT 3,410,400
MOISTURE IN COAL AND IN AIR 426,300
TOTAL FURNACE LOSSES 4,695,100
UNABSORBABLE HEAT IN FLUE GASES 1,280,907
TOTAL BOILER LOSSES 1,280,907
FRICTION AND RADIATION 216,885
TOTAL PIPE LOSSES 216,885
EXHAUST 7,627,331
FRICTION IN ENGINE 119,177
TOTAL ENGINE LOSSES 7,746,508

Fig. 1—Fuel and Heat Losses Between Mine and Crank Shaft

unit (B.t.u.), from which it is evident that each pound of air during the transition period on being heated to 500 deg. F., absorbs 125 heat units and therefore the 14 lb. of air required to burn each pound of coal absorbs 14 × 125, or 1,750 heat units. From this it is evident that all air in excess of this amount admitted to the furnace will carry away a large number of heat units, which is waste pure and simple. The waste then resolves itself into two factors, which include the amount of air entering the furnace and the temperature rise.

For determining the amount of CO_2 and CO the apparatus most frequently used is some form of the Orsat apparatus and no investment in power plant equipment will yield a larger rate of interest than a well used gas-analysis apparatus. Other equipment which is also indispensable includes the pyrometer and draft gage. By the use of the pyrometer the temperature of the excess volume can be determined, for in order to determine the preventable heat loss from excess air it is necessary to know the temperature as well as the volume. Draft regulation is one of the most important factors in combustion efficiency and the amount of draft should be such as to produce the best percentage of CO_2 without CO and still meet the load conditions.

These various appliances all have merit and conditions should be studied very carefully in the power plant with the view to their adoption as the initial cost is practically nil, considering the ultimate saving that can be realized by their installation. One of the greatest obstacles in the past has been the unwillingness of a large number of plant managers to spend a few dollars on the nonproducing part of their plants, but this is to a large degree being overcome, particularly during the past three or four years.

Fuel Waste and Where It Goes

The question is often asked, "How can coal be saved?" This is a question upon which much has been written during the past few years, and rightfully so, as the coal bill in all power plants has now become a vital factor and must necessarily receive the most searching kind of investigation.

When it is taken into consideration that a ton of good-grade coal delivered to the power plant contains approximately 29,000,000 B. t. u. and that the average plant delivers to the point of power only approximately 554,000 to 555,000 B. t. u. it is well nigh time to "sit up and take notice." As an illustration of where the losses occur in the average power plant the diagram in Fig. 1, taken from Joseph W. Hays' treatise on "How to Build Up Furnace Efficiency," will prove of interest.

It will be noted that by far the greatest waste is caused by the large amount of excess air that is permitted to enter the furnace and boiler setting and to escape up the chimney, which is carrying away heat that should otherwise be utilized to perform useful work. This unnecessary air is admitted in two ways, through uneven fires which leave part of the grates bare and through leaky boiler settings.

The loss due to uneven fires can properly be charged to improper operation and this is one of the important factors regarding which the fireman should be properly informed in order to correct it.

The loss due to leaky settings is even more important for the reason that it is not so easily detected. This forms an enormous preventable loss and the question of tight boiler settings is not debatable, therefore one of the first and important steps is to insure that the boiler settings are made tight with a suitable air-tight coating. This coating should be of a nature that it will expand and contract with the brickwork as well as being capable of withstanding the high temperatures, and retain its elasticity. Such a compound is on the market; it is cheap, easily applied and presents one of the best investments that can be made. Too much stress cannot therefore be brought to bear on this important matter of maintaining the settings in such a manner as to have them free from leaks. Fuel losses measured by CO_2 and flue temperatures are shown in Fig. 2.

Leaky Baffle Walls and Settings

Unless baffle walls are tight, part of the hot gases from the furnace will short-circuit or take a direct route from the fires to the stack, whereas with perfectly tight baffles the gases must follow the path prescribed for them and pass over the entire heating surface. Excessive leakage through the first baffle, or the one nearest the fire, can often be detected by looking through the dusting-doors or peepholes just beyond the baffle.

In constructing or repairing baffle walls, joints should be eliminated wherever possible, whether between sections of the baffle or around tubes. The more nearly air-tight the wall

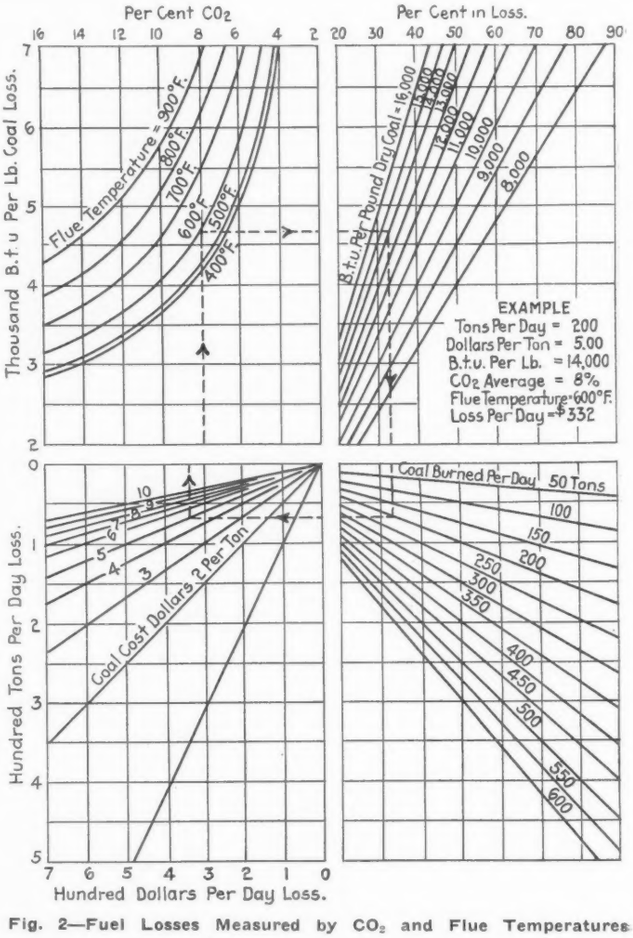


Fig. 2—Fuel Losses Measured by CO_2 and Flue Temperatures

can be made, the higher will be the efficiency of the boiler; this is no doubt generally conceded to be a fact by all power plant men.

Every substance expands and contracts under temperature changes. In each 180 deg. iron changes one part in 800 approximately, while firebrick changes one part in 2,000, which of course is a great variation. The result is that the iron-work expands more than the brickwork, and there is necessarily a slight relative movement between them as the expansion takes place. As the boiler cools the reverse condition occurs and this contraction and expansion soon develops cracks and openings so that the settings require close attention at all times. These leaks can be located by the method referred to heretofore or by throwing a scoop or two of green coal on the fire and closing the damper tightly. In

this case the result is the reverse; the pressure inside the furnace is increased and smoke will soon be emitted through any opening or crack by which air would enter.

Another source of leakage commonly overlooked is in the division walls between boilers set in batteries. Leaks in these walls are just as bad as in outside walls, as the live boiler will draw cold air from the dead one and the ultimate results are the same.

Efficiency of Combustion

It has been found that a proportion of about 11.5 lb. of air to every pound of carbon in the coal is necessary in order to insure complete combustion and furthermore this quantity of air must actually come in contact with the fuel. Incomplete combustion is due mainly to two causes, namely—insufficient air supply and failure of air to mix with the combustible rising from the fuel bed. Air is just as necessary for combustion as is the coal itself and for every pound of coal burned on the grate, 7 lb. of air must be admitted to flow through the bed of coal.

It is also very necessary that the bed be kept uniform and free from holes as the majority of air flowing through the holes does not aid in the combustion. On the other hand it

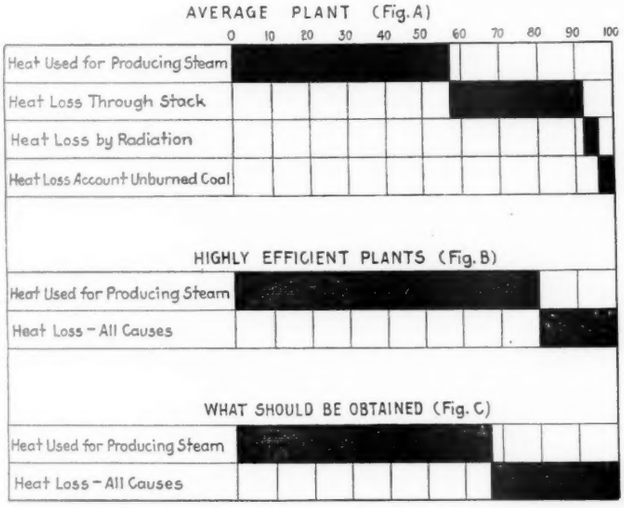

AVERAGE PLANT (Fig. A)
0 10 20 30 40 50 60 70 80 90 100
Heat Used for Producing Steam
Heat Loss Through Stack
Heat Loss by Radiation
Heat Loss Account Unburned Coal
HIGHLY EFFICIENT PLANTS (Fig. B)
Heat Used for Producing Steam
Heat Loss – All Causes
WHAT SHOULD BE OBTAINED (Fig. C)
Heat Used for Producing Steam
Heat Loss – All Causes

Fig. 3—Chart Showing Field for Saving in Heat Losses in Power Plants

absorbs a large amount of heat that is carried out and lost through the stack.

The additional air needed to aid combustion should be admitted as close to the fuel bed as possible at a high velocity through small openings to bring the combustion up to the highest efficiency. Under no circumstances should this excess air be admitted through holes in the fire. As stated heretofore it requires approximately 14 lb. of air for burning one pound of coal, and in view of the fact that the swift passage of air causes some of it never to reach the fuel, air excess as high as approximately 40 per cent of the air conveying the oxygen required should be used, this depending upon the furnace construction. This matter of combustion could very easily be dwelt upon at length without covering the whole field and only the more important factors can be referred to in this article.

The construction of the furnace also regulates the quantity of excess air required for complete combustion and in some cases it may be as low as 12 per cent or 15 per cent, but it is not considered advisable to go below 20 per cent and may go as high as 40 per cent.

If the composition of the fuel is known, the percentage of excess air may be found approximately by the following formula No. 1:

$$\text{Percentage of excess air} = \frac{2100}{CO_2\ (1+3H)} - \frac{100+238H}{1+3H}$$

in which

CO_2 = Percentage of Carbon Dixoide in flue gases.

H = Weight of available hydrogen per pound of carbon in coal burned.

By the application of this formula when the percentage of CO_2 is known the important factor, excess air, can be ascertained. Efficient combustion results when the fuel is burned completely with the minimum amount of excess air and no further air is permitted to admix after combustion is completed. Complete combustion liberates all the heat contained in the fuel but efficient combustion requires that the heat be liberated in such a way as to give the maximum effect for producing steam; combustion efficiency can then be stated as shown by formula No. 2:

$$\text{Combustion efficiency} = \frac{\text{Heat available for making steam}}{\text{Heat contained in fuel burned}}$$

The heat carried away and lost up the chimney may be determined by formula No. 3. Although the results do not indicate all the heat wasted, yet it will be close enough for all practical purposes and shows the heat loss in B. t. u.'s per pound of carbon burned.

Formula No. 3

$$\text{Heat losses in flue gases} = \left(0.24 + \frac{58.46}{CO_2}\right) \times T$$

CO_2 = Percentage of Carbon Dioxide in flue gases

T = Difference between the temperature of the escaping gases and the temperature of air in boiler room in degrees "F."

It has been found in the average steam plant that the distribution of the heat in the coal is about as represented in Fig. 3. From figure A in this diagram it will be noted that for the average plant about 57 per cent of the heat is utilized for the actual production of steam, while about 43 per cent is lost. Figure B is representative of what is obtained by the best performances or about 80 per cent of heat utilized for producing steam and 20 per cent lost. Figure C shows what should be obtained and by increasing the percentage from 57 per cent to 67 per cent, which would mean a saving of about 15 tons of coal out of every 100 tons.

(To be concluded in the March issue)

If a belt slips after being cleaned and properly adjusted, it is probably overloaded, and the size of the pulleys should be increased.—*The Melting Pot.*

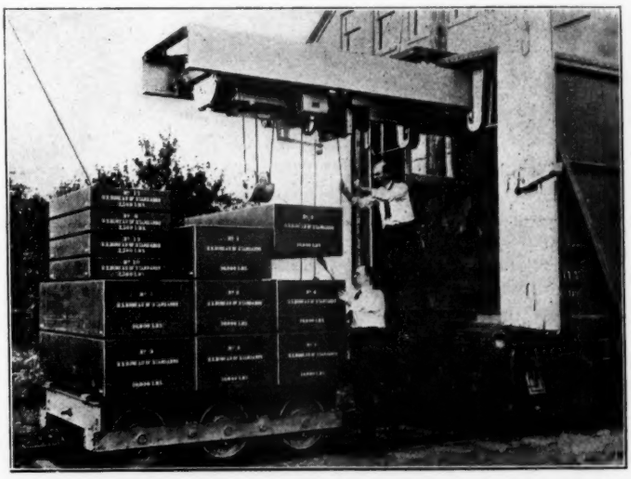


Photo by International

A Track Scale Testing Car of the Bureau of Standards

Labor Board Opens Hearings on Working Conditions

Carriers Oppose Perpetuation of National Agreements; Employees File Charges Against Roads

THAT the national agreements between the railroads and various classes of their employees, instituted within six months before the end of federal control, should not, in the interests of "honest, efficient and economical management" be continued longer under private operation, was contended by representatives of the railroads before the Railroad Labor Board on January 10 during the opening hearings on the demand of railway employees for the perpetuation of these agreements.

"The only parties who are fully qualified to consider such regulations are the individual managements and their employees," testified E. T. Whiter, chairman of the Conference Committee of Managers of the Association of Railway Executives, which is presenting the carriers' side of the controversy.

The reasons for the carriers' opposition to national agreements were outlined in the opening statement on behalf of the railroads. This opposition, according to Mr. Whiter's testimony, is based on the facts that:

(1) They are ultra-restrictive and therefore prevent the honest, efficient and economical management demanded by the transportation act;

(2) The variable conditions in different sections of the country make the universal application of their provisions impracticable;

(3) The existing rules, the continuation of which is proposed by the men, are capable of various constructions;

(4) The existing agreements provide that the rules contained therein shall apply to all employees of any particular craft regardless of the department of the railroad in which the man is employed; thus leading to a division of jurisdiction and a conflict in the working rules applicable to employees engaged in the same work;

(5) The existing agreements have destroyed acknowledged efficient and economical practices such as the piecework system for regulating rates of pay;

(6) The railroads must have relief from the rules controlling the employment of men, which are so restrictive as to prevent them from obtaining a sufficient number of employees in certain departments, thus interfering with output and causing delay to the movement of traffic;

(7) The agreements contain many rules which provide for payment of work not performed, and thereby cause many millions of dollars of unnecessary expense annually.

"The railroads do not object to schedules (the technical term for railway agreements) properly negotiated and entered into with their own employees," Mr. Whiter said, "as is evidenced by the fact that nearly all, if not all, of the roads represented by this committee, have had schedules with the various train service organizations for many years.

"Prior to federal control, some roads had schedules with other classes of their employees; many had no schedules with any crafts other than the train service organizations, but there were no so-called 'national agreements' which made all rules uniformly the same throughout the country. All roads that did have schedules directly negotiated them to fit their own conditions with their own men, and in every case the railroads had the undisputed right to negotiate their own schedules, which was denied during federal control.

"Under governmental control the railroads were unified, and the director general entered into so-called 'national agreements.' These agreements, which were of universal application for the period of federal control, were specifically recognized by the parties signatory thereto as effective during this period only."

During subsequent hearings Mr. Whiter presented testimony regarding the shop crafts agreement, showing how the rules operated to increase labor costs exorbitantly and decrease efficiency. As readers of the *Railway Mechanical Engineer* are familiar with this matter no attempt will be made to report the details of the testimony.

Mr. Whiter's testimony regarding this agreement was completed on January 18, following which representatives of several of the larger carriers presented detailed statistics to show that the abolition of the piece work system of pay in railroad shops has resulted in serious decreases in the efficiency of the individual worker and consequently in the output of the shops.

Unions Criticize Contracts for Repairs

At the opening of the hearings on January 10, B. M. Jewell, representing the American Federation of Labor, presented a statement in which he attacked the contracts for repairs which the railroads have made with outside shops. W. Jett Lauck, representing the International Association of Machinists, filed a petition for an investigation of these contracts with the Interstate Commerce Commission, although the commission had already announced that such an investigation was already under way.

The petition charged that the big railroads, "especially those affiliated in a financial way with J. P. Morgan & Co., are closing their repair shops, throwing thousands of union men out of work and giving repair work at extortionate rates to large private equipment companies in which railroad capitalists or banking groups are heavily interested." It was also stated that more than 30,000 union men already have lost their jobs under this plan and a combination of figures was built up as the basis for a statement that the railroads are "milking the national treasury of three-quarters of a billion dollars and manipulating the funds in a campaign to drive the railroad unions out of business," and that in this fashion the railroad managements hoped "to send the unions on the rocks and charge the bill to the public through taxation to pay the subsidies guaranteed by the federal government or by maintaining present high rates."

Neither the press statement nor the petition explained that the car and locomotive repair work was sent to outside shops during the guaranty period during which, under the law, the railroads will be allowed to charge to maintenance expenses for the purpose of figuring the guaranty only an amount to be determined by the Interstate Commerce Commission, nor that most of the lay-offs of shop employees referred to occurred at a later period, after the volume of railroad traffic had been greatly reduced. The petition stated that locomotive repair work when done in the outside shops costs the railroads on an average four times as much as it costs in their own shops. The petition suggested the following policy for correcting the alleged evils:

"1. That no railroad company be permitted to enter into contracts for repair work on locomotives or cars by outside companies unless given a permit to do so by the commission, and

"2. That as a condition to securing such a permit, the railroad companies must show: (a) They cannot do the work which they wish to contract for, or (b) They cannot do it at as low a cost as they can have it done by outside companies, and (c) If a permit is granted, that the same

rates of compensation and the same conditions of employment will be observed by the contractors as are recognized and guaranteed to railway workers by the Transportation Act of 1920, and the Awards of the Railway Wage Board established by this Act."

Later another statement was given to the press quoting Mr. Lauck as to the alleged actual records of contracts for repairing 617 locomotives and about 32,000 cars during the past several months. The following table was given as showing a comparison between railroad and private shop costs on the basis of the data secured by the unions and those ascertained by the Railroad Administration:

COST OF LOCOMOTIVE REPAIR WORK BY PRIVATE COMPANIES AND COST OF SIMILAR WORK IN RAILROAD COMPANY SHOPS IN AUGUST AND SEPTEMBER, 1920

Number of locomotives	Name of company doing work	Total cost	Average cost per locomotive
234	Baldwin Locomotive Works	$4,691,176	$20,048
27	Rome Locomotive Company	459,000	17,000
41	American Locomotive Company	670,760	16,360
9	Lima Locomotive Works	149,535	16,615
11	Charleston Dry Dock Company	66,000	6,000
9	Southland Steamship Company	54,000	6,000
10	Merrill & Stevens	120,000	12,000
6	Broad Foot Iron Works	72,000	12,000
1	Pittsburgh Boiler & Mch. Co.	1,670	1,670
2	Manufacturers Railway Shop	25,080	12,540
350	Total and weighted average	$6,309,221	$18,026
1,080	Railroad Company Shops	$5,504,144	$5,096

In this statement it was stated that the locomotive repair bill under the private contract system would be raised from $500,000,000 a year to $1,500,000,000 annually and the car repair bill from $400,000,000 to $800,000,000, a total increase of $1,400,000,000.

Practically all the data regarding the cost of repairs, as included in the statements of the machinists' union, were brought out in a speech by Congressman Huddleston of Alabama in a recent speech in the House of Representatives. In the report of the speech contained in the Congressional Record, a tabulation of contracts for repairs to locomotives and cars is shown with a further statement of the cost of classified repairs in certain railroad shops. The data regarding repair contracts show that the cost per locomotive ranges from $1,670 to $30,275.70. Practically no information is given as to the extent of the repairs. The work done in railroad shops is subdivided under the various classes of repairs, the cost being as follows:

Class 1	$26,069.23 (one road only)
Class 2	8,195.64 to $14,498.14
Class 3	4,471.66 to 10,658.39
Class 4	2,093.71 to 4,576.11
Class 5	1,002.09 to 4,025.45

Railroads Reply to Charges of Labor Leaders

Following the publication of these charges many of the railroads gave out detailed statements defending the contracts for repair work. It was pointed out that in many cases the terms were the same as in contracts made by the Railroad Administration.

Thomas DeWitt Cuyler, chairman of the Association of Railway Executives, issued an official statement in which he denied the charges of labor leaders that railroads were paying excessive costs for equipment repairs as an attempt to deceive the public. At the conclusion of his statement Mr. Cuyler said:

"When the railroads were returned to private operation there was an abnormal percentage of cars and locomotives in bad order requiring repairs. The excess of bad order equipment was beyond the capacity of the railway shops, and the railway labor engaged in the repair of cars had declined in efficiency and output. These abnormal conditions required abnormal remedies to meet them. It was a matter of time and economy to utilize all the facilities of the equipment concerns of the country for these repairs.

"There is absolutely no truth in the charge that banks and railroad companies are in a 'conspiracy' against labor, the 'open shop,' or upon any other controverted point."

QUESTIONS AND ANSWERS

Location of Cylinder Center Above Center Line of Axles

Why is the center line of cylinders in most locomotives placed about 1½ or 2 in. above the center line of the axles?—H. C. Wilson.

The principal reason for placing the cylinder center line above the center line of the axles is to provide for wear in the driving box crown brasses and settling of the springs. If the cylinders and wheels are placed at the same level, the cylinder would be lower than the center line of the wheel after the engine had been in service or after the crown brasses had been bored. This would result in an undesirable condition as it would cause the thrust of the cross head to act downward at certain points in the stroke when running ahead. Normally, this pressure is against the upper guide.

Another advantage in locating the cylinder center above the center of the wheels is the fact that it raises the guides and reduces somewhat the amount of dirt that lodges on them. In some cases, it may also give increased clearance for the leading truck. Raising the center line of the cylinders above the center line of the axles increases the angularity of the main rods and shifts the dead centers so that they are not diametrically opposite. This introduces some errors in the valve gear but with the long main rods ordinarily employed, this is so small as to be negligible.

Finding the Speed of Trains

How can the speed of a train be found without timing it between mile posts?—J. B. Johnson.

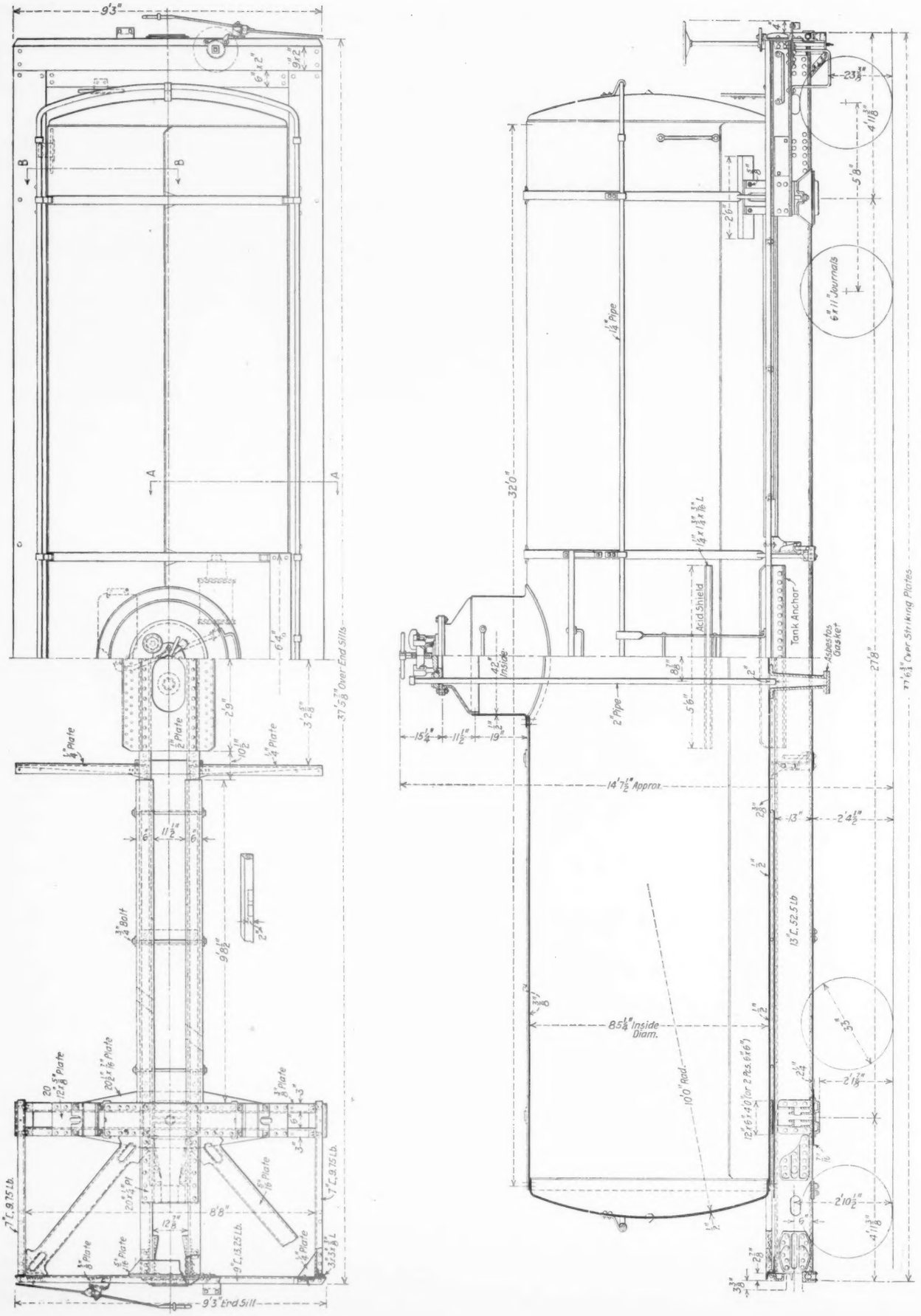
When running on double track, one of the easiest methods of finding the speed of a train is by counting the rail joints on the opposite track. Practically all rails are now made 33 ft. long, in which case the speed can be determined by counting the rail joints passed in 22½ sec. When riding in passenger cars, it is often possible to determine the speed by counting the clicks as the trucks pass over the joints.

In case the noise of the joints cannot be heard or if they cannot be seen, as for instance on single track, the speed can be found from the revolutions of the driving wheels. The time during which revolutions should be counted depends, of course, on the diameter of the drivers and can be determined as follows:

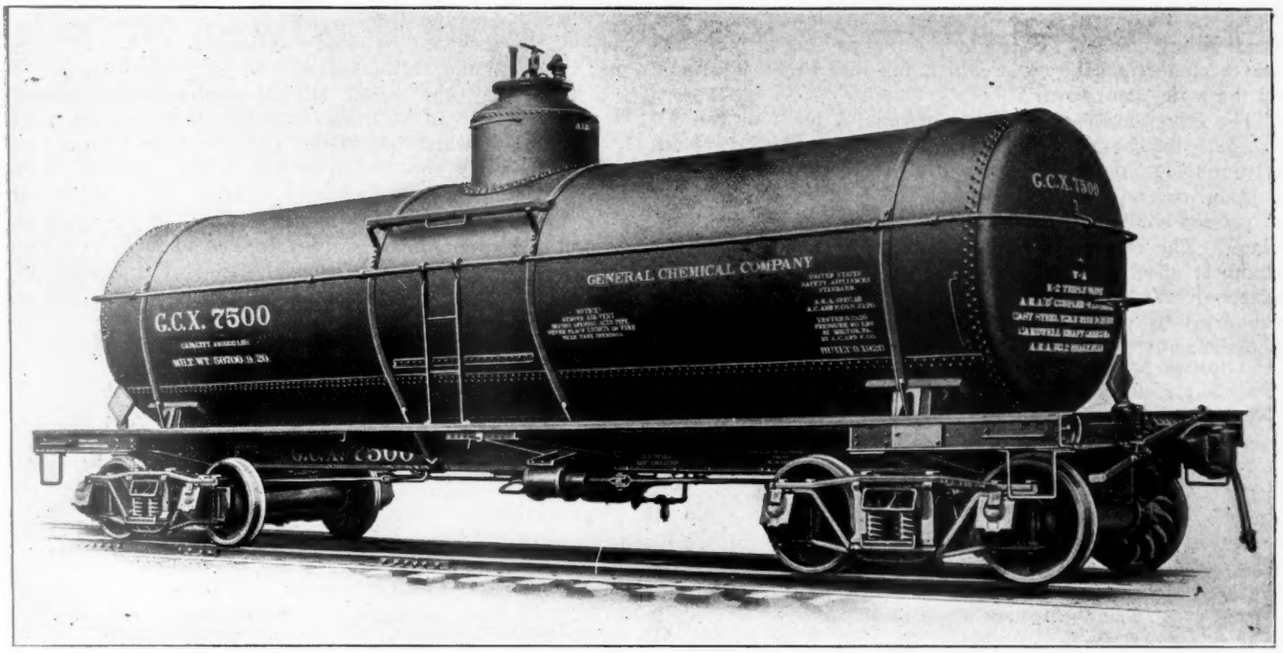
Find the number of revolutions per mile and divide this into 3,600 (the number of seconds in one hour). This will give the time in which the revolutions will equal the speed in miles per hour. For instance, if the drivers are 63 in. in diameter, their circumference is 16.46 ft. and they will make 312 revolutions per mile. The speed will be equal to the number of revolutions (3,600 divided by 312), or approximately 11½ sec.

Where trains made up of cars of uniform length are operated, the speed can be determined by counting the number of cars passing a given point, the time being found as above, substituting the length between couplers for the circumference of the drivers. Counting telegraph poles likewise affords approximate means of finding the speed.

ORGANIZED RAILROAD LABOR, after a year of success in obtaining higher wages and promoting unity, faces the inevitable economic readjustments connected with post-war business reconstruction in 1921. The railroads face easier labor conditions, increased individual efficiency and a return to "an honest day's work for an honest day's pay" basis. Attitude and action of Railroad Labor Board will have a large influence upon a mutually satisfactory adjustment of the differences.—*Railway Age.*



Plan and Side Elevation of General Chemical Company 70-Ton Acid Tank Car

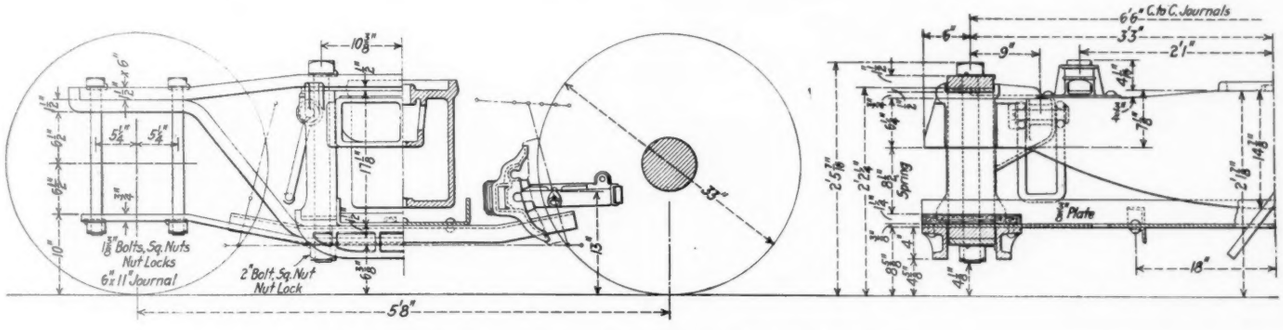


Sulphuric Acid Tank Cars of 70 Tons Capacity

Tank Made with Three Longitudinal Sheets Is Feature of Equipment Built for General Chemical Company

THE transportation of dangerous chemical products in large quantities has become so common that it receives but little attention from the railroads that move this traffic. To build equipment which permits handling such commodities in regular service without extraordinary precautions requires a high degree of skill in design and high-class workmanship. This is well exemplified in the recent order of 70-ton tank cars built by the American Car & Foundry Company for the General Chemical Company. These cars have a capacity of 9,800 gal. of sulphuric acid. The concentrated acid is nearly twice as heavy as water and if any considerable quantity of water comes in contact with the liquid, a violent explosion will occur. For this reason, the tanks must be strong, absolutely free from leaks and the dome must be tightly sealed.

With the exception of two cars built for the General Chemical Company in 1916, the 50 cars on this order are, so far as known, the first 70-ton acid tank cars constructed. The design was worked up jointly by the American Car & Foundry Company and the General Chemical Company, the owner's arrangement of dome fittings and outlets being applied. The tank conforms to the A. R. A. Class III tank specifications and is built to withstand a pressure of 300 lb. per square inch. The diameter inside the sheets is 85¼ in. and the length between the outer rows of rivets is 32 ft. The cylindrical section of the tank is made up of three longitudinal courses, each in one piece. The length of riveted seams is reduced considerably by this design. The bottom sheet is ½ in. thick, the upper sheets ⅜ in. thick and the heads ½ in. All rivets and seams are caulked on the inside and all seams are caulked on the outside as well. The dome has an inside diameter of 42 in. and is 30½ in. high with a cast steel dome head. The dome cover, which is also a steel casting, carries the usual safety vent with lead disc and a flange for the syphon discharge pipe. This pipe extends through the tank and into the outlet chamber,

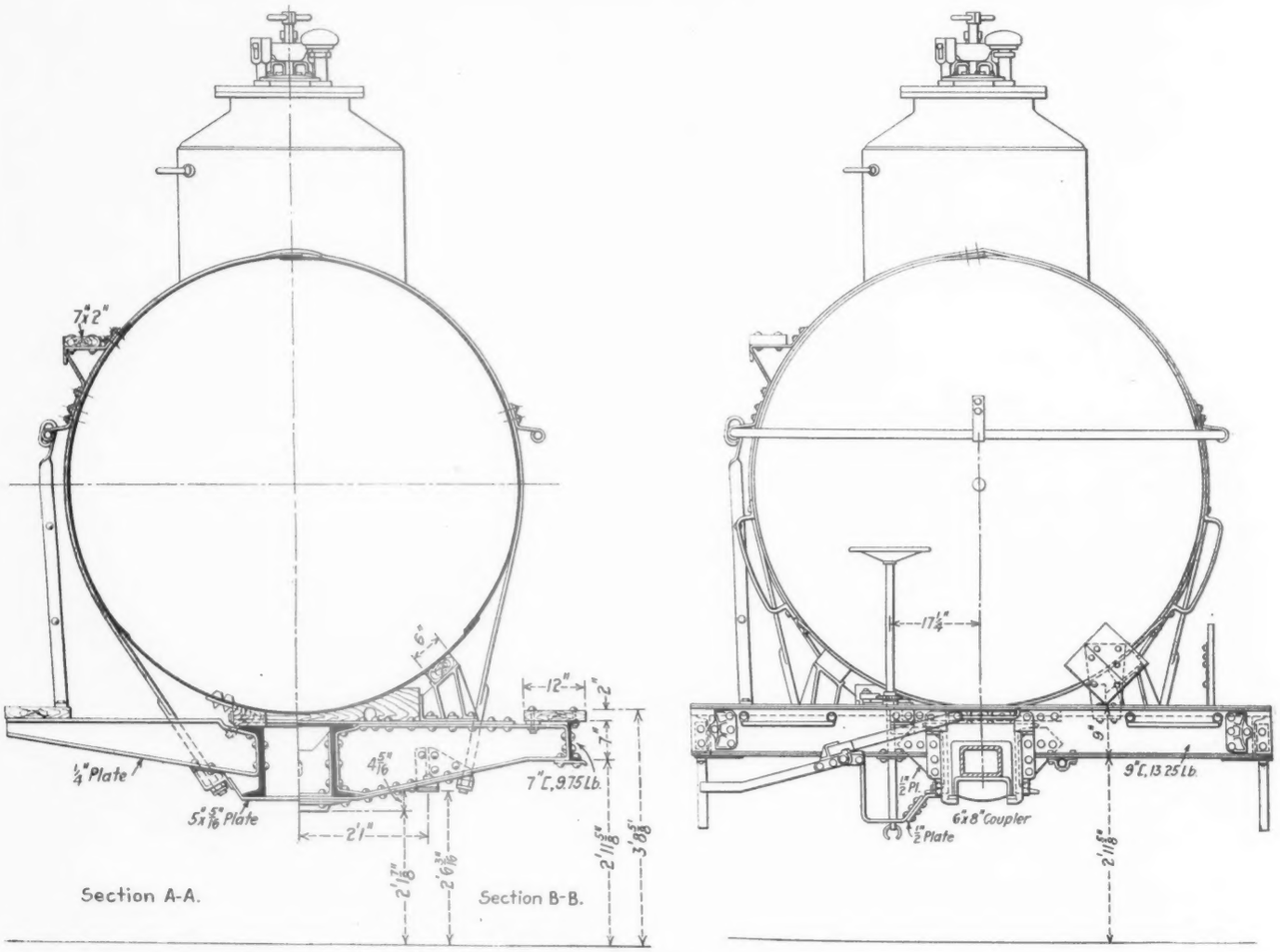


Arch Bar Truck Used With 70-Ton Tank Car

which is fitted with a blind flange at the lower end. The small filling cover is secured by a screw passing through the center of a removable yoke which fits into two toggle bars on the main dome cover.

The center member of the underframe is made of two 13 in., 52.5 lb. channels spaced 12⅞ in. apart. These extend continuously from end sill to end sill and are reinforced by a ¼-in. cover plate 20 in. wide. The bolsters are built up of pressed sections of ⅜-in. plate with top and bottom cover plates. The end construction comprises a 9 in., 13.25 lb. channel; short side sills of 7 in. 9.75 lb. channels; and diagonal braces of 5/16-in. plate. The running boards are supported by pressed steel cross bearers. A ½-in. anchor plate extends across the center of the underframe and the outer edges are bent down to conform with the outline of angle-shaped anchor plates riveted to the tank. The arrangement of the two parts of the anchor is such that the underframe is given a slight downward camber at the center and the tank is relieved of any stresses due to buffing shocks which otherwise would be transmitted to the sheets. The rivets which join the tank and the underframe are made readily accessible by this arrangement so that they can be riveted by machine and the tank can be removed for repairs without cutting any of the rivets in the tank itself. Practically all center anchorages on tank cars have been bolted to the underframes as outlined in the tank car specifications and a riveted anchor is a comparatively recent innovation. An acid shield on each side of the tank protects the anchorage and the air brake equipment in case acid is spilt from the dome while the tank is being filled or emptied. The ends of the tank rest on wood saddles held by bracket castings on each side of the bolster. An additional support is provided along the center sill by wedge-shaped wooden stringers which can be drawn together by transverse bolts.

The trucks, which are of the arch bar type, have a base casting spanning the bottom of the bolster opening. This furnishes a means of attachment for the spring plank and also provides support for the lower end of the pedestal column. Many of the specialties applied to these cars were furnished by the General Chemical Company, including the safety vent, outlet castings, dome heads and fittings and all tank gaskets. Other equipment includes Cardwell G-11-A draft gear, Westinghouse type KD-1012 brake equipment, National journal boxes with coil spring lids, Huntoon brake beams and Stucki side bearings. The average light weight of the cars is 50,400 lb.



End Elevation and Cross Section of General Chemical Tank Car

To Clean a Lead Spot, it is advisable to add dry, common salt, and stir thoroughly with the molten lead. All dirt and foreign matter will rise to the surface, and can be skimmed off with ease. —From Houghton's "Steel and Its Treatment."

Steam-proof Belt Cement.—Many engineers are of the opinion that lacing must be used on belts exposed to steam, as belt cement will not hold under such conditions. While this is true of some kinds of cement, steam will not dissolve a belt cement made on a pyroxylin base because it is waterproof and not affected by moisture.

Cause of the Present Condition of Freight Cars*

Pooling, Deferred Retirements, Labor Conditions and Abuse in Service; the Remedies Suggested

BY J. C. FRITTS

Master Car Builder, Delaware, Lackawanna & Western, Scranton, Pa.

WHEN a bad condition is found an effort should first be made to find the cause and then work out some method by which the evil can be combated. So much has been said in regard to tightening nuts, opening cotter keys, measuring piston travel, etc., that I thought we might pass that part of car maintenance tonight, assuming that it was being well taken care of, and go a little deeper, with a view of suggesting something constructive.

In order to properly analyze the present unsatisfactory condition of freight cars, it will be necessary to go back two or three years and ascertain what has occurred during that period that would contribute to the present situation. If this can be determined with any degree of accuracy, then we should be able to suggest something that will give us relief.

Effect of Pooled Equipment

Formerly it was common practice to maintain the majority of cars on home lines, but during the war the pooling of freight cars was deemed necessary, and cars on home rails in many instances were reduced to ten per cent of the equipment owned. It does not seem at present that we are going to get back to previous conditions in this respect for some time to come, if ever. The result has been, and still is, that a very large percentage of cars in bad order are of foreign ownership, for which the handling line does not carry in stock standard material, except a few M. C. B. parts. Therefore, in lieu of repairing in kind, improper and temporary repairs have been made in order to return the cars to service.

All railroads throughout the country have been repairing cars in this manner. It was the best they could do under existing conditions. Such methods are responsible in a very great measure for the condition of freight car equipment at this time.

A check and inspection of system cars received home at interchange points developed that a very large percentage were in need of extensive repairs and a large number had defects that could have been repaired by using standard material. This would seem to indicate that returning equipment to owners only when it has become unserviceable is being practiced to a very great extent.

Imagine what is going to happen with 75 per cent or more of all cars in the country on other than owning lines with conditions of this kind existing. I do not mean to say that there has been willful neglect on the part of railroads in general, but an analysis of the situation shows that these things have been forced upon them by the scarcity and mixing or pooling of equipment.

Repairs to cars have been retarded:

First, because the car department forces have not been familiar with the class of cars they have been required to repair and necessarily have consumed more time than was customary on home line equipment.

Second, it was formerly customary to manufacture parts for system cars in large numbers which were placed in stock and could be used as needed. They were made with standard patterns, formers, dies and other labor saving devices, at the minimum of time and expense, but with foreign cars in the majority on shop tracks this practice could not be continued, as there was not a sufficient number of system cars received to warrant the manufacture of various parts in any great amount. Practically all such parts for cars of foreign ownership require special operations through the manufacturing section of our shops, thereby losing the benefits of the labor saving devices that were previously in use. This has resulted not only in reducing the shop output, but has greatly increased the cost of production.

*Presented before the Western Railway Club, Chicago, January 17, 1921.

Old Cars the "Weakest Link"

Train tonnage is being increased from day to day; heavier locomotives are built with greater drawbar pull, and two or more are coupled together on heavy grades, or where it may be necessary to maintain fixed tonnage; heavy rails with rock ballast have been laid; new and stronger bridges have been constructed and all modern appliances for transportation have been adopted. The freight car from 15 to 20 years old is expected to take its place in this line of modern improvements and successfully perform service that is two or three times greater than was originally intended when the car was built. It is unreasonable to expect the old freight car to function efficiently against such odds.

If we were handling the same train tonnage with the same locomotives that were used when the cars that are failing were built less trouble would be experienced. The sooner railroads strengthen the weakest link in transportation, which is the car, the quicker results will be obtained. Many of these cars are of old and weak construction and their failure not only results in damage to themselves, but frequently causes serious damage to other good cars that are being handled with them. The majority of these cars are repaired in kind instead of being dismantled, as was formerly the practice.

Cars with short draft timbers, extending from end sills to body transom, of which there are many thousands in service, cannot be handled with any degree of success with present transportation methods. Cars of this construction that have had new sills and ends applied and generally repaired, in many instances have them torn out and destroyed within a few miles of the shop where repairs were made. A number of railroads, however, have started to apply reinforcements, some of which are of substantial construction, while others are little improvement, if any, over repairing in kind, and seem to have been contrived to reduce the expense of application rather than to give service. The results of such a practice is, that the expense of upkeep, not considering service, will soon equal the cost of proper reinforcements and the weak cars will still be on your hands. This is false economy, and it would seem that the design of reinforcements for freight equipment is not being given the thought its importance deserves.

If this is true, and we all know it is, then surely something should be done to eliminate or prevent repairs of this character.

Effect of Labor Conditions

The labor situation has also contributed very largely to present conditions. Many of the old employees have worked faithfully and endeavored to produce an honest day's work, but as a whole they have not manifested the same interest or given the same loyal support as was formerly their practice.

There seems to have been a spirit of getting by with the least possible amount of work and indifference as to the quality as well.

The leveling of rates for all mechanics in the carmen's craft has reduced shop output instead of increasing the production, as was expected by some of the advocates of this system. All men are not of the same ability, and the highly skilled mechanic feels that he should not produce more than one of lesser skill because he is receiving the same rate of pay. This is human nature, and we cannot expect a change in these principles until a different method of compensation has been inaugurated.

Railroad shops are among the very few manufacturing plants throughout the country where all mechanics are placed in one class regardless of skill, and where the thrifty and industrious employee is supposed to produce a sufficient amount of work without extra compensation as compared with the man with a shiftless and lazy nature. Such a system is wrong, as it not only works an injustice and hardship upon the employee, but the employer as well. The right of every man to earn in accordance with his skill and ambition to produce, should not be denied him. It is one of the fundamentals upon which the Constitution of our country is based.

Rules and regulations that required years to work out and establish for the other crafts, were put into operation at once in car department forces, with the result that there was a lot of confusion which finally was adjusted with not enough men in the country with the experience required by the rules, to cover the work then on hand. There was no method of creating more until three years had elapsed, and then only through the helper apprentice system. The duties of carmen are so varied and cover so many distinct lines of work that rules which govern blacksmiths, machinists and some of the other crafts cannot be applied to carmen in so short a period and meet all of the various conditions of car work.

The rules insofar as they refer to supplying carmen are not workable because they have closed the door on increasing the number of men that can be employed at this work. On account of the centralizing of authority, the former close personal contact between the employee and those in charge has ceased to exist; supervisors are not free to settle questions that may come up from time to time, but must be governed by decisions handed down by men who are many hundred miles away and who perhaps never have been on the grounds and certainly are not familiar with local conditions. Ability cannot be considered and is not a factor in promotion at this time. Seniority governs in all cases, at least to the extent of a trial, with the result that there are entirely too many trials and very little production in the meantime. All of these things and perhaps many others that could be mentioned have all had a tendency toward a general lowering of the employees' morale.

The effect of such a condition is reflected in the present condition of freight car equipment. These restrictions have affected shop operations to such an extent that it has been found impossible to maintain bad order cars within a reasonable percentage.

The Misuse of Equipment

We hear much in regard to speeding up and increasing efficiency in operation; that more cars must be loaded and carry a greater tonnage; that the miles per car per day should be increased. But those in charge seem to have lost sight of the fact that a great factor in bringing about these results is keeping the greatest possible number of cars in service, and that this in a great measure depends upon the manner in which they are handled. Very little, if any, attention or consideration is given to the misuse of equipment. The only thought seems to be of delivery and loading or unloading, and if damaging or mutilating the car would in any way assist in this operation, there is no hesitancy in doing so. It is not uncommon, however, to receive complaints about the large number of cars it becomes necessary to bad order after receiving usage of this nature.

These destructive methods have been gradually on the increase for the last two or three years, and have not been confined to hump and classification yards. At piers and wharves, and in fact, at all loading and unloading points, the abuse of cars is always in evidence. It has become almost impossible to maintain cross ties, brake staffs and wheels, where clamshell unloaders are in use, notwithstanding the fact that these must all be replaced before the car can be returned to service.

Roofs, doors, door tracks and fixtures, flooring, lining, and in fact any part of the car that might affect the unloading operation, are torn off and destroyed, apparently without the least thought of the important position the freight car holds in relation to moving the country's traffic.

Many thousands of cars are thus damaged and sent to shop tracks daily, which otherwise could be loaded again without repairs, not only reducing the cars out of service on account of bad order but greatly assisting in increasing car mileage and the number of cars loaded.

While the material situation has improved during the last two or three months, it has contributed its share in full measure to the difficulties that have been experienced in properly maintaining cars in serviceable condition. Manufacturers have received orders in excess of their capacity to produce, and when finished, the scarcity of cars very often prevented prompt shipment of the material. This and embargoes placed on company material from time to time made proper and prompt repairs impossible even though other facilities were adequate.

With all of these conditions existing, is it any wonder that we find freight cars run down and worn out, and need those in charge of car maintenance feel that they have fallen short in the performance of their duties? I believe you will all agree with me in stating that they have done well, all things considered.

The following suggestions will assist in relieving the present unsatisfactory condition of freight cars throughout the country.

When possible from a traffic standpoint, cars should be returned to owning lines where repairs can be made. The old and light constructed cars could then be dismantled or assigned to special home line service and those that warrant being continued in service should receive substantial reinforcements that would be in keeping with the service they are required to perform.

All railroads are under moral obligations to do this, because they expect such cars to be accepted and handled in through line traffic by other railroads. Under the present system of pooling equipment through Commission orders, etc., a railroad that builds and reinforces in line with good practice will receive very little benefit from so doing, unless all other roads do likewise, because the exchange of cars between railroads has increased to an extent that 75 per cent of equipment on line is of foreign ownership and cars that receive extensive repairs today will probably leave the home line tomorrow and not return for several years. Therefore, there should be some agency established between railroads that will prevent the application of reinforcements or the perpetuating and offering of cars in interchange traffic that are unfit from a strength standpoint for general service.

All railroads have had sufficient experience to indicate to them that cars with short draft arms extending from end sill to body bolster cannot be handled with any degree of success, especially on trunk lines in heavy tonnage trains, and after a reasonable length of time has been given, they should be refused in interchange regardless of type or capacity. A very large percentage of the present bad order equipment can be confined to approximately 400,000 cars in the United States.

All that the majority of these cars need to make them serviceable for many years to come is the application of proper reinforcements.

If the pooling of cars is to continue and it becomes impossible to return them to home rails, then so far as it may be practical, certain common standards applicable to the most of this equipment should be adopted. These should be applied regardless of where the cars may be. This would not only hasten placing them in proper, serviceable condition, but would very materially assist in their future maintenance.

The General Committee of the Mechanical Division of the A. R. A. should appoint a committee for this purpose, and work out a system that would enable all railroads to reinforce such cars when placed on shop tracks for extensive repairs, regardless of ownership.

The condition of many cars received home shows that repairs for which standard material could have been used have not been made, indicating that cars of foreign ownership are not receiving the attention that present conditions would warrant or permit.

Under the present arrangement a railroad should, so far as possible, give the same consideration to foreign cars that it does to its own cars, and the failure to do so will react against the proper maintenance of freight equipment as a whole.

It has been stated that the writer is in favor of no labor unions and low wages, and that in saying so, he has voiced the sentiments of the "higher-ups." Nothing could be further from the facts. I believe in labor organizations that are conducted on just and moral principles, and that every man is entitled to fair and just treatment and his day in court. No superior of mine has ever suggested or even intimated to me what my views should be on this subject. Employees are entitled to safe and sanitary working conditions and regardless of the class of work a man performs, if he is willing to produce an honest day's work, he is entitled to a good living wage—by that I mean, enough for himself and family to live comfortably, to educate his children, and without extravagance, to lay away something besides. And treating this as a basis, every man should be paid according to his ability and willingness to produce. It is the only fair and just method of compensation, and a system that would make this possible should be inaugurated.

Rules that have been found to be unworkable and those that have inflicted unjust and unreasonable penalties on employers should be replaced with others that will equitably and fairly meet the conditions they are intended to cover. Men who are thoroughly familiar with their class of work should be placed in charge. They should understand human nature and the difficulties under which employees must at many times perform their work; men that will keep in close personal contact with those under their charge and who are quick to see and correct a wrong, regardless of where it may exist. No man feels satisfied to perform his duties from day to day without some recognition from his superior outside of the salary he may receive. Every faithful employee is entitled to this consideration. It not only creates a relationship of good will and loyalty, but inspires the employee to do better and more efficient work.

Supervisory officers of this type with proper authority ought to be able to meet and settle questions that may arise from time to time without the necessity of referring them to higher authority. If this is done, we should get back the morale and co-operation of our employees, which is very necessary in order to build up our production to a normal output.

So many cars are being damaged through carelessness, in many instances bordering on malice, that something should be done to prevent the destruction of company property by the misuse of equipment. I am somewhat at a loss for a proper and effective solution of this problem, but some sort of a campaign is necessary, because in many instances, those in charge appear to give this very important question no more thought than the employees they supervise. Much money could be saved if it could be instilled in the minds of those handling them, including some transportation officers as well as dock foremen and yardmasters, that cars are constructed, not to be damaged and mutilated, but to perform a very important service in connection with the life of our nation.

In view of the fact that a very large percentage of the damage to freight cars is caused by shock, draft gear maintenance is worthy of serious consideration at this time. The question of type or style of gear must be left open for further tests and investigation, but I believe that we should get the best out of whatever type we have in service. They perform more work and receive harder usage than any other device on a car, and it is the only one for the inspection and maintenance of which there are no specific rules laid down.

The function of a draft gear is primarily to keep down the pressure in the car underframe when under impact, which is done by increasing the length of time the forces are distributed through the car during such impact, in other words, by draft gear travel. It should always be remembered that none of the forces resulting from impact or collision are destroyed, but all remain in the car underframe to be disposed of or dissipated in one way or the other. Any wear or broken part that causes slack, reducing the effective travel of the gear, hastens the closing point, after which the pressure in car sills or underframe increases very rapidly.

If the function of the draft gear is as important as I believe we will all admit, then surely some systematic method of inspection and repairs should be installed on all railroads. We find that this is necessary in the maintenance of air brakes, wheels, and couplers. The cost to make such inspection or adjustments would not necessarily be greater than the expense of cleaning and repairing the air brakes, which the law compels railroads to do at least once a year, and I feel sure that the saving would be many times greater than the cost.

A periodical inspection should be arranged for and the dates should be stenciled on the car in a manner similar to the present practice with respect to air brakes.

Discussion

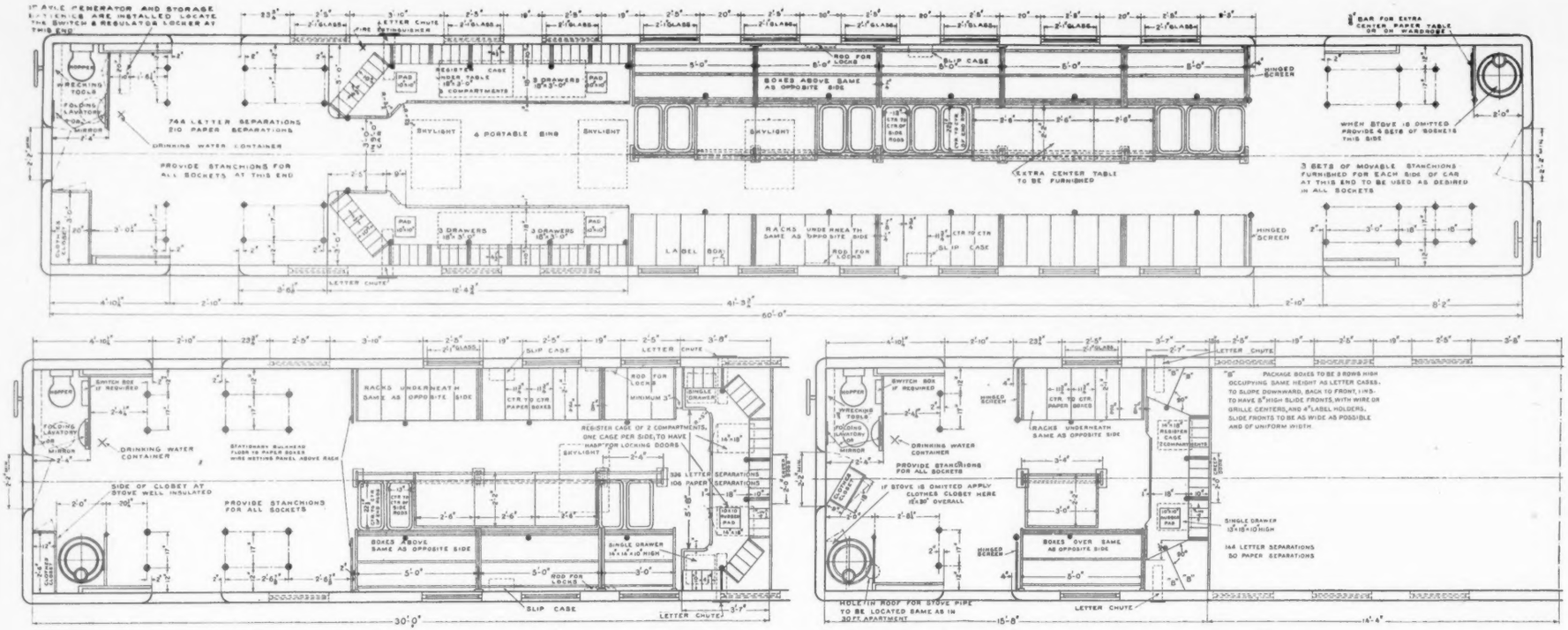
The paper drew forth a discussion on a wide range of subjects pertaining to the maintenance of freight cars. Several speakers referred to the frequency with which draft gears and attachments and box car ends were damaged and the suggestion of the writer of the paper that standard repairs generally applicable to all old equipment be developed by the Mechanical Division of the American Railway Association was favorably received, particularly as to standard car ends and draft reenforcements.

Several speakers called attention to the extent to which old cars with wood draft arms extending only as far back as the body bolster are receiving extensive repairs, as much as $1,200 being expended on heavy repairs to such cars, which are liable to fail immediately on being placed in service. Although the retirement of such cars was advocated several times during the discussion, it is evident that Rule 120 of the interchange rules has not accomplished its purpose.

C. N. Swanson (Atchison, Topeka & Santa Fe) strongly advocated fixing the A. R. A. prices for labor and material so high that owners would be forced to take proper care of their own equipment and that when cars are repaired on foreign lines the repairing road would be able to do the work at a profit.

C. J. Wymer (C. & E. I.) also advocated the policy of setting A. R. A. prices high enough to include a profit. In

(*Continued on page* 101)


74A LETTER SEPARATIONS
210 PAPER SEPARATIONS
DRINKING WATER CONTAINER
PROVIDE STANCHIONS FOR ALL SOCKETS AT THIS END
4 PORTABLE BINS
SKYLIGHT
BOXES ABOVE SAME AS OPPOSITE SIDE
ROD FOR LOCKS
SLIP CASE
EXTRA CENTER TABLE TO BE FURNISHED
3 SETS OF MOVABLE STANCHIONS FURNISHED FOR EACH SIDE OF CAR AT THIS END TO BE USED AS DESIRED IN ALL SOCKETS
WHEN STOVE IS OMITTED PROVIDE 4 SETS OF SOCKETS THIS SIDE
HINGED SCREEN
LABEL BOX
LETTER CHUTE
RACKS UNDERNEATH SAME AS OPPOSITE SIDE
REGISTER CASE OF 2 COMPARTMENTS, ONE CAGE PER SIDE, TO HAVE HASP FOR LOCKING DOORS
336 LETTER SEPARATIONS
106 PAPER SEPARATIONS
SINGLE DRAWER 16"x14"x10" HIGH
SWITCH BOX IF REQUIRED
FOLDING LAVATORY AND MIRROR
STATIONARY BULKHEAD TUBES TO PAPER BOXES WIRE NETTING PANEL ABOVE RACK
SIDE OF CLOSET AT STOVE WELL INSULATED
IF STOVE IS OMITTED APPLY CLOTHES CLOSET HERE 6'x20" OVERALL
PACKAGE BOXES TO BE 3 ROWS HIGH OCCUPYING SAME HEIGHT AS LETTER CASES. TO SLOPE DOWNWARD, BACK TO FRONT, 1-IN. TO HAVE 8" HIGH SLIDE FRONTS, WITH WIRE OR GRILLE CENTERS, AND 4" LABEL HOLDERS. SLIDE FRONTS TO BE AS WIDE AS POSSIBLE AND OF UNIFORM WIDTH
SINGLE DRAWER 12"x18"x10" HIGH
144 LETTER SEPARATIONS
80 PAPER SEPARATIONS
HOLE FOR ROOF FOR STOVE PIPE TO BE LOCATED SAME AS IN 30 FT. APARTMENT

Plans for Interchangeable 60-Ft. Full Railway Post Office Car and 30-Ft. and 15-Ft. Apartment Cars, (R. M. S. Drawing, Sheet O.)

(1) 60-FT. FULL R. P. O. CAR

This floor plan shows size and location of doors and windows so as to permit car body being used as a 60-ft. full car, a 30-ft. or 15-ft. mail apartment. When used as a 60-ft. full car, the windows shown in full lines and the three skylights shown by dotted lines are required. The windows shown in dotted lines can be installed complete in original construction, or provision made in framing for completion as required.

To facilitate widening of side doors, so that the entire car, or part of car, may be used in other than distributing mail car service, extra posts may be provided in side walls, of such nature as will permit widening the doors at minimum cost.

(2) 30-FT. APARTMENT

This plan locates doors and windows so as to permit the apartment being reduced to 15 ft. without change in this respect. If car is fitted up as a 30-ft. apartment when originally constructed the windows shown in full lines and the skylight in dotted lines are required. The windows shown in dotted lines can be installed complete or provision made in framing, for completion when change to 15-ft. apartment is made.

If it is contemplated that car may be changed at any time into a 60-ft. full car, the additional doors, windows and skylights shown on the 60-ft. plan can be installed complete, or provision made for these in framing, to be completed as required.

(3) 15-FT. (15 FT. 8 IN.) APARTMENT

The use of this plan, in lieu of the standard plan shown on R. M. S. Sheet F revised February 2, 1920, is optional. This plan is designed to permit the apartment being extended to 30 or 60 ft. without change in size or location of doors or windows. This involves the use of side doors of same width as those in 30 and 60-ft. mail cars, and the same space for toilet as in the larger units. These differences make the apartment 8 in. longer than the 15 ft. 0 in. shown on Sheet F, although there is no increase in the facilities in the apartment. Apartments built on this plan will be rated the same as the 15-ft. apartment shown on Sheet F.

(4) If length of car, inside measurement, exceeds 60 ft., the excess over 60 ft. should be added between side door opening and end of car. If this excess is greater than 3 ft., stove should be located at same end of car, on opposite side, and adjacent to door opening, with bulk-head of insulated metal plates to height of stove and wire netting panel above. Face of bulkhead to be flush with edge of door opening.

(5) *Skylights:*—Total exposed glass area of each, 5 sq. ft.; 60 ft. full car, three should be provided; 30-ft. apartment, one should be provided as shown. Where it is contemplated changing apartment to 60-ft. full car, the other two skylights may be installed complete or provision made in framing only; to be used as required; 15-ft. apartment, none required. Where it is contemplated changing apartment to 60-ft. full car the three skylights may be installed complete or provision made in framing to be used as required. Where it is contemplated changing a 15-ft. apartment to 30-ft. skylight called for in 30-ft. plan, may be installed complete or provision made in framing only to be used as required.

(6) *Bulkhead Radiators, Wall Coils:*—If used in 60-ft. car, locate bulkhead radiator on stove side, and wall coil on opposite side, at this end of car. At hopper end locate bulkhead radiator in stall adjoining clothes-closet. In 30-ft. apartment, locate bulkhead radiator in stall adjoining hopper, when stove is used. When stove is omitted locate radiator on wardrobe side. In 15-ft. apartment, locate bulkhead radiator in stall adjoining stove.

Bulkhead radiators should be located so that wire guard will be flush with door opening. Bulkhead radiator may be considered as equivalent to one set of movable stanchions. Wire mesh only, of ½ in. mesh heavy gage, to be used as heat pipe guard.

(7) Electric lighting shall be designed to furnish specified illumination on distributing facilities as shown on plans and on additional facilities required, when a 60-ft. full R. P. O. car is changed into an apartment car, the generator box should be moved into the baggage or passenger apartment of the car. Provision for making such change at minimum cost may be made in original construction.

(8) *Drinking Water Container, Drains:*—Drain pipes should be curved immediately under the container to side of bulkhead, or preferably, should empty into lavatory drain pipe, to insure minimum interference with piling of mail.

(9) Stove, if required, to have coal box under bulkhead insulated to top of stove, with wire netting panel above.

(10) Side door pockets to be solid, with opening along face 1½ in. to 2 in. high for removal of dirt from track.

(11) Brake wheel chain not to be applied inside of car.

(12) *Catcher Arm Brackets:*—Brackets for catcher arms and cinder guards to be applied at all side doors. Center of core of catcher arm brackets to be not less than 3 ft. 9 in. from floor of car.

(13) *Ventilators:*—Arrange layout as far as practicable so that correct number and kind (exhaust and intake, or combination) of ventilators will be in the various sizes of mail rooms.

(14) Hoppers, both flushing and dry, shall have double lids.

(15) *Overhead water tanks:*—Capacity must meet specifications for any size of mail room that may be provided in car body.

(16) Wall, deck and floor attachments securing distributing facilities (letter cases, letter case tables, racks and boxes for papers) shall be of such design as will permit of ready removal of facilities without defacement of car body, and permit substitution of sections of letter case and table for sections of racks and boxes for papers and vice versa. Attachments for securing letter case and table to be used as far as practicable for securing racks and boxes for papers, and same design of attachments to be used on all cars of any one railroad system.

Frame to be furred to support lighting and heating fixtures, letter cases, racks, rack latch dog (to engage rod No. 2 of the rack), boxes for papers, stanchion sockets, etc., as applied in car originally or when size of mail room may be changed.

(17) Hooks to be applied on side walls, over racks or in storage stalls, for hanging bridges.

(18) Paper boxes to have their own back which shall not answer for headlining.

(19) Indicates candle lamp brackets.

(20) For complete details of construction, refer to specifications revised February 2, 1920.

Note:—If railroad companies do not desire to use convertible features in 30-ft. and 60-ft. plans, windows shown in dotted lines may be disregarded. This refers to construction of car body only. See Note 3 regarding use of Sheet F for 15-ft. apartment.

Railroad companies contemplating the ordering of new mail car equipment will notify the department of their decision on these points.

this connection Mr. Wymer also advocated making all defects owners' defects and balancing this with a rental charge high enough to reimburse the owner for the upkeep of the equipment.

The effect of the present condition of freight cars on operating costs was touched on by D. I. Bergin (Wabash), who stated that hot boxes and bad orders created enroute were prolific causes of excessive fuel consumption and crew overtime. He called attention to the fact that all a railroad has to offer in competition is the service it can render; weak equipment which causes delays in the movement of traffic seriously affects the quality of this service.

In closing, Mr. Fritts called attention to the 40-ton cars with short draft timbers, many of which are in service, as needing equally as much attention as the 30-ton cars frequently referred to in the discussion. These cars, from the very fact that they are permitted to carry heavier loads may be even a greater menace than the similar cars of lighter capacity.

New Plans and Specifications for Postal Cars and Fixtures

The United States Post Office Department, Division of Railway Mail Service, has recently issued new plans and specifications for the construction of steel full and apartment cars and drawings and specifications for fixtures for mail cars.

The outstanding differences in the floor plans are the convertible feature of changing a 15-ft. distributing unit into a 30-ft. unit, or a 30-ft. unit into a 60-ft. unit, or vice versa. In order to permit of these changes, a common arrangement of door and window openings has been adopted. The new plans, which are similar to the optional layout issued in 1917, are shown on the opposite page. The distributing facilities have been rearranged, especially in the full railway post office car, so that the paper racks are kept together in line. A different letter case has been adopted and the distributing facilities built in units and made detachable so as to secure easy rearrangement.

In all three sizes, the letter case boxes are now 10 in. deep. On account of the large proportion of correspondence passing through the mails being enclosed in long envelopes, it was necessary to discard the short letter boxes which were shown in former plans and which were 7½ in deep. This facilitates the distribution by the clerks and tends to eliminate errors which might occur due to the long letters, when placed in the short letter boxes, obscuring the labels designating the boxes.

Comparatively few changes have been made in the specifications for the construction of postal cars. A new paragraph has been added to cover the design of self-propelled cars where the weight of the operating unit does not exceed 200,000 lb. The specification for skylights, which formerly called for ¼ in. rough wired glass or ⅜ in. rough plain glass, now specifies ½ in. rough wired glass or rough plain glass of equal strength. A few minor changes have been made in the requirements for lighting. If Mazda Type C lamps are used, they must have frosted or enameled bowls. Lights at letter cases are required to be located high enough so that the shadow of the reflector is not cast on any of the label holders. For emergency lighting, candles melting at relatively high temperatures, 120 deg. or more, must be used such as the Argand-Stearine or equivalent. The earlier specifications provided that if globes or reflectors of certain types were used, the service illumination values might be reduced 20 per cent from the minimum values otherwise required. Aluminum reflectors have now been added to this list. In the construction of protection guards for heating pipes, the use of wire netting or perforated metal was formerly optional with the railroad but the present specifications call for wire netting only. A note has been added stating that steel vestibule diaphragms are preferred. The rule for the location of brake and signal equipment provides that where apartment cars have but one signal valve, this shall not be located in the mail apartment. A few minor changes have been made in the list of interior equipment.

In the section pertaining to trucks, the detailed requirements in regard to brake shoe pressure and maximum weight per journal have been eliminated. A new sheet has been issued showing the approved standard lettering for the outside of mail cars.

Specifications for Fixtures

The principal change in the specifications for fixtures is the requirement that letter cases, tables, racks and boxes for papers shall be made up in standard sections and shall be secured to the car body by attachments of such design as will permit of ready removal of these fixtures without defacement to the car body and will permit substitution of sections of letter case and table for sections of racks and boxes or vice versa.

As noted above the letter cases have been changed and all boxes are now required to be 9¼ in. deep. The use of wood is not permitted in backs or perforated bottoms. Where partitions are made of wood, the material must be three-ply, thoroughly seasoned. Slight changes have been made in the requirements for label holders. The use of wire screen for the back of letter cases is no longer permitted. The details of letter cases are shown on railway mail service drawings, Sheet 50, which supersedes Sheets 1, 2, 3 and 4 and Sheet 5, Fig. 3.

Minor changes are made in the requirements for racks. The specification for package boxes and boxes for papers states that when the deck of a mail car is of such width that the top of boxes for papers projects more than 5 in. into the deck opening, the top of that portion of the boxes projecting into the opening shall be covered with wire screen of not less than ½-in. mesh. When the boxes project less than 5 in., the fronts of the boxes at the top are to be beveled sufficiently to prevent the obstruction of light and to avoid a shelf on which dust can accumulate. The beveled front may be of wood or metal. Cages for registered mail were formerly required to be made of wire netting, but they may now be constructed of wire netting or perforated metal. The installation of a gas plate or a steam cooker and a portable cot is no longer required.

The specifications for catcher arms have been changed by adding the requirement that the round rod used in the arm must be made of open hearth steel of not less than 0.40 or more than 0.60 per cent carbon content. The bracket for the catcher arm applied to the side doors shall be located not less than 3 ft. 9 in. from the floor.

A Blue Print Bath

BY A. G. JOHNSON
Mechanical Engineer, Duluth & Iron Range, Two Harbors, Minn.

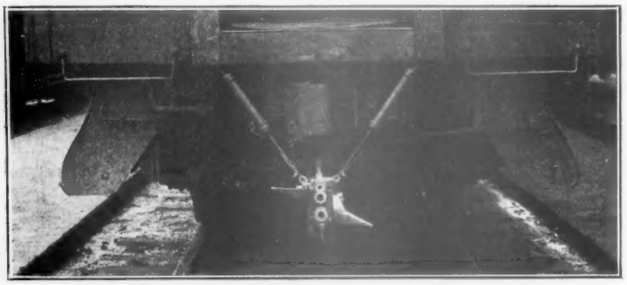
A solution of one ounce of bichromate of potash to three gallons of water makes an ideal bath in which to wash blue prints, as it will darken the color and fix the chemicals so the prints will not fade. The print must be exposed slightly longer than when clear water is used and it is well to rinse after removing from the bath. The solution can be used indefinitely by replacing the water that evaporates and, when running water is not available, it is almost a necessity.

It is always well to have a bichromate solution handy in any blue print room for use in bringing back over-exposed prints, in which case the best practice is to first wash the print in clear water for a few minutes and then immerse it in the bichromate bath and rinse. Nice clear whites will result.

The Futrell Automatic Train Line Connector

New Type Suspension, Positive Lock for Connector Heads and Removable Gasket Plate Are Features

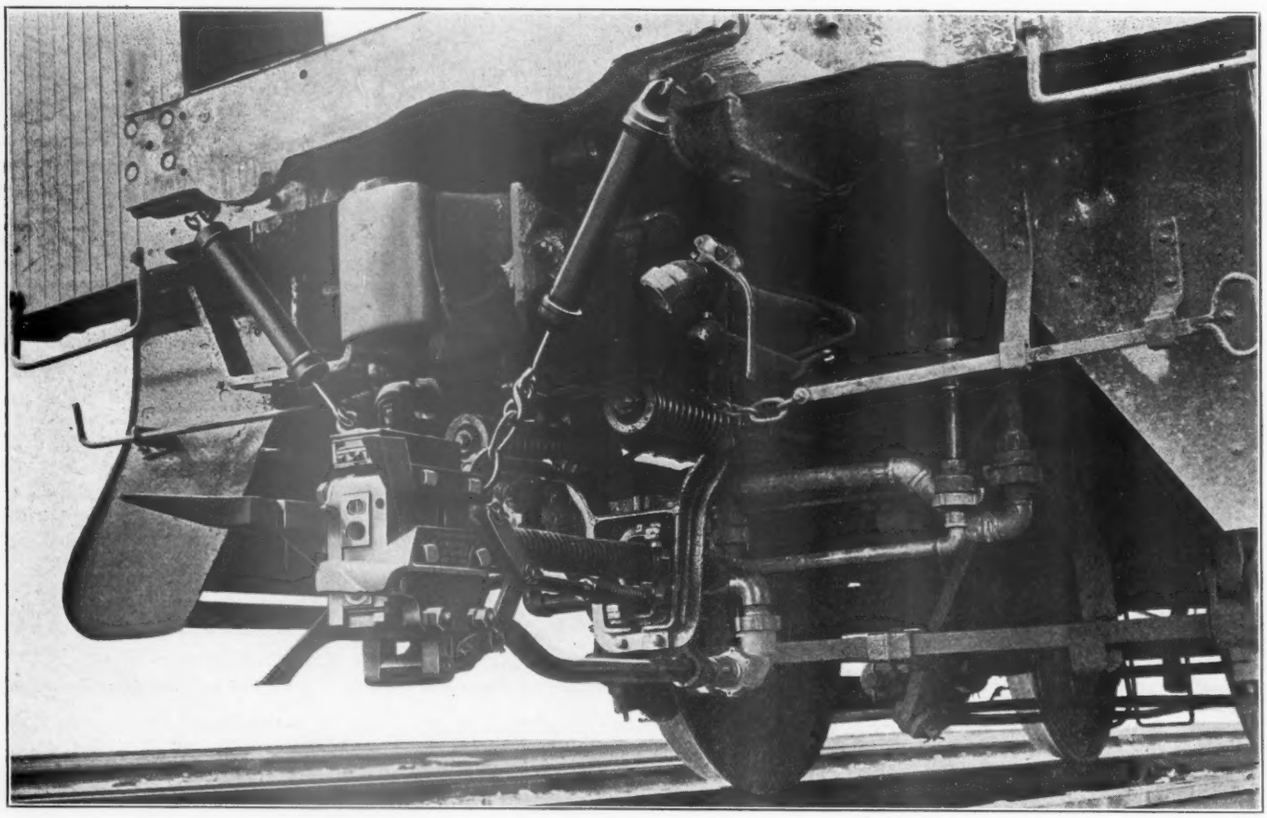
DURING the past 18 months the Baltimore & Ohio has had in service on a local passenger train a new design of automatic connector. This device, which is the invention of Thomas J. Futrell, is made by the Futrell Coupler Company, Streator, Ill. While the construction follows the general principles of some of the existing types, there are several unique features, the most notable being the arrangements for locking the heads and taking care of movement between coupled cars.



End View of a Car Equipped With the Connector

The coupler, as shown in the illustration, is of the butt-face, wing type. The head casting is suspended beneath the coupler by diagonal wire cables which are supported by an enclosed spring mechanism from the car body. A bracket is attached to the center sill behind the coupler carrier iron and a yoke shaped lever, pivoted to the bracket, supports a stem which extends from the rear of the coupler head. Two springs attached to the bracket force the yoke forward and another spring is applied to the stem of the coupler head. These parts are adjusted so that the connector when not coupled extends 5¾ in. ahead of the pulling face of the coupler knuckle.

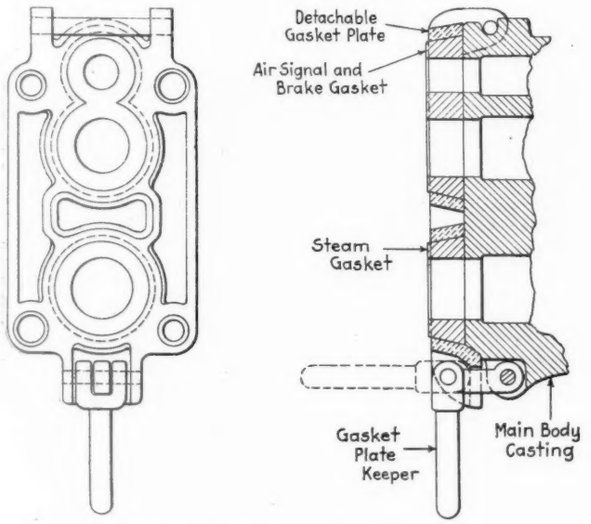
Beneath the main stem of the connector is an auxiliary stem with a spring adjustment. This stem operates a lock through a toggle arrangement and after the connector faces are in contact the lock is caused to engage a slot in one of the wings as it mates with the coupler head. The details of operation of the locking arrangement are clearly shown by drawings of the side and front views of the head. In a recess in the head beneath the left side wing is a segment, *a*, pivoted near the upper edge. The portion of this segment lying within the head serves as a stop for the locking bar, *b*. The lower outer edge of the segment extends into the guide in which the wing of the opposing connector engages the head. Thus as the wing moves in it will force the segment upward and release the locking bar, which is then free to enter the slot in the wing. When the connectors are separated the locking bar is returned to the lower position and the segment, being released as soon as the wing is removed, returns to its original position by gravity.



The Futrell Connector, Showing Suspension, Piping and Electric Contacts

The heads, when locked, form practically one solid part and since the connectors are supported from the car body,

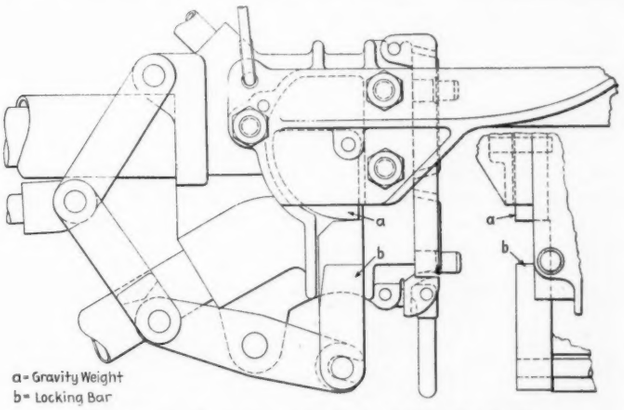
it is necessary to provide sufficient freedom of movement to insure that no additional stresses are placed on the heads by the relative movement between the ends of adjacent cars.



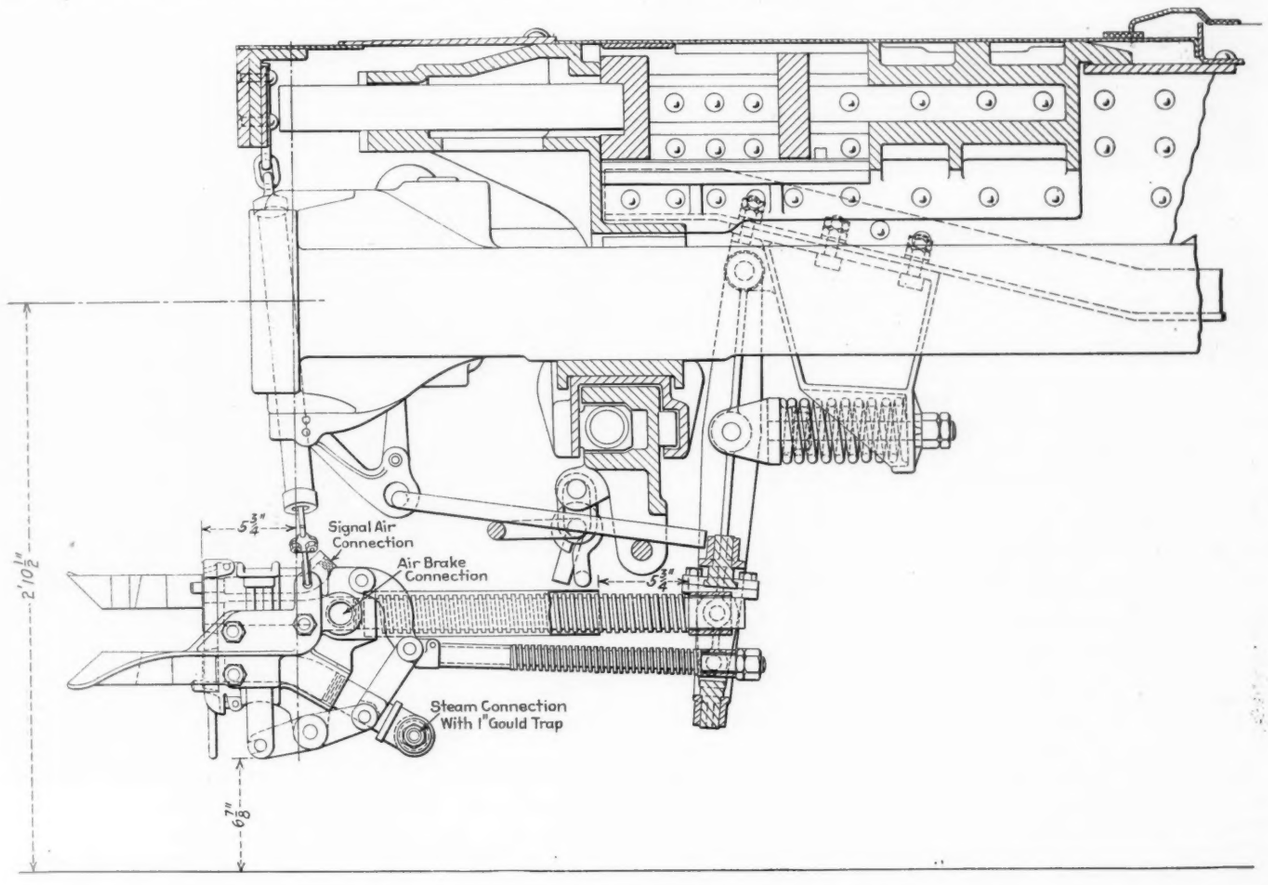
Details of Removable Gasket Plate

The yoke shaped lever, being pivoted at the upper end, is free to move forward or backward to take up motion resulting from the compression of the drawbar springs and a trunnion casting between this lever and the stem of the coupler head provides for lateral and vertical movement.

The wing type gathering mechanism has a vertical range of 7 in. and a horizontal range of 7 in. On the earlier designs, four wings were used, but the latest type has but two. An additional means of insuring perfect alinement in the head is provided by two pins in the face which register with recesses in the opposing connector head. As is the usual practice in this type, the ports are located on the vertical center line, the air signal connection being at the top; the air brake in the center and the steam heat at the bottom. The sizes of the openings are as follows: air signal 7/8 in.; air brake 1 3/8 in.; steam heat 1 1/2 in.



Side View of Head Showing Locking Mechanism



Side Elevation of the Connector Head and Suspension

The gaskets are held in place by a detachable gasket plate fastened to the front of the head. The plate is hinged at the top and is locked at the lower end by a cam which forms part of the gasket plate keeper. In order to remove the gasket

plate, the handle must be raised to the position shown by the dotted lines. When the two connectors are coupled, the handle is held in the vertical position and there is no possibility of the plate becoming unfastened. It will be noted from the illustration that the gaskets are tapered to fit the plate and the air brake and signal ports have a single gasket in common. With slight changes in the gasket holder, A.R.A. standard air hose gaskets could probably be used. In the design of the head, provision has been made for the attachment of electrical connections at the top of the head casting.

All connections between the connector head and the train line are made by pipe and flexible joints, both the Barco and McLaughlin type being used. In order to make the connections to the head, tees are inserted in the train lines behind the angle cocks. Ordinary air cocks are used in the air connections and a quick opening throttle valve in the steam passage. The levers for the operation of these cocks are placed toward the center of the car just behind the steps, where they can be reached from the side without going between the cars. The piping and cocks to which the rubber hose are connected are not disturbed in the installation of the coupler and for that reason no other provision is made for interchanging with equipment fitted with the standard connections.

A Side View of the Connectors in the Coupled Position

Journal Packing Reclamation

Journal packing represents a considerable item of cost in car maintenance. Various roads have developed different methods of reclaiming packing removed because of cut-journals, hot boxes or in the course of ordinary repairs. The method illustrated and described in this article has been devised and tried out with exceptionally good results.

The journal packing as received at the oil house is placed in the large vat shown in Fig. 1, in the bottom of which are steam coils. As it is "cooked" in the oil boiled out and left from previous boilings, the packing is stirred around from time to time. During this stage of the operation, much of the dirt, grit, babbitt, etc., is worked out, after which the warm, spongy packing is transferred to the table of an air press, shown at the end of the boiling vat. This press has a cylinder about 30 in. in diameter and exerts a pressure of approximately 35 tons, effectively squeezing out any oil remaining in the packing, the oil draining off through the base of the press and the molasses gate seen near the front of the press.

This oil, together with that secured in the boiling vat, is filtered thoroughly through a three-stage water filter illustrated in Fig. 2, the operation of which is as follows: With all tanks full of water to their respective overflow points, oil is poured into the right hand tank and overflows down the first pipe. The difference in head is sufficient to force the oil and water ahead of it down the first overflow pipe and into the bottom of the second tank, a movement which continues as long as oil is poured into the first tank. Being

Fig. 1—Sheet Iron Boiling Vat Used in Initial Removal of Dirt and Babbitt from Journal Packing

lighter than water, the oil rises slowly in finely divided parts through the water in the second tank to its overflow pipe. As the oil rises, solid particles of dirt and grit, heavier than water, separate from the oil and sink to the bottom of the tank. This operation of filtering the oil continues through the three stages when it is finally drawn off from the bottom of the last tank. As occasion demands, each tank is cleaned

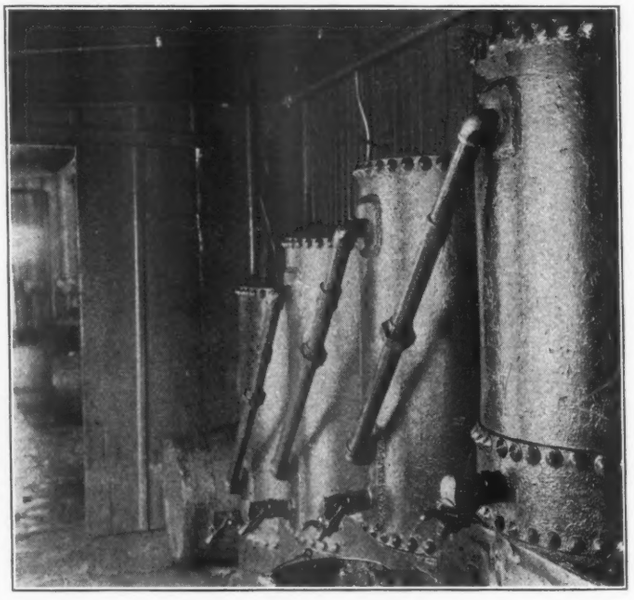


Fig. 2—Three-Stage Water Filter for Cleaning Oil

by opening the gate at the bottom and drawing off enough water to remove all sediment and collected dirt.

The dry wool waste is taken to a screening table with a diamond shaped screen opening, the length of each side being 1½ in. Being thoroughly forked over this screen, all short lengths are worked through as well as any dirty residue. The resulting waste and filtered oil are used without addition of new material in making up packing for freight car equipment.

The Use of Wood in Freight-Car Construction*

Relative Merits of Steel and Wood for Open and Closed Top Cars—Use of Graded Lumber

By H. S. SACKETT
Assistant Purchasing Agent, Chicago, Milwaukee & St. Paul

THE fact that over two billion feet of lumber and timber are used annually in the United States for the maintenance of freight equipment and for the construction of new cars, representing an annual outlay for material alone of over $50,000,000, is ample evidence of the importance of wood in this big industry.

The first freight cars used for railroad transportation in this country were built of wood and this great natural resource has been an important factor in their construction ever since. In recent years steel has competed with wood, especially in the construction of gondola and other types of open-top cars, but whether this change has been an economical one or not remains a question.

From recent studies made of the subject by disinterested commissions, the indications are that even for open-top cars, wood is still the most economical material. With the growing scarcity of timber, however, and the apparently unlimited supply of steel available, it is probable that this latter material will always be a prominent factor in the construction of cars, and especially so, if some agent is found to reduce materially the present high rate of loss from rust and corrosion.

In the construction of the first cars wood was almost universally used for all parts, except of course the running gear. Within the past decade, however, with the introduction of heavy motive power, which spells long and heavy trains, it has been found that wood is no longer capable of withstanding the heavy shocks incident to such operation, and it is generally conceded by all car builders that the freight car of the future must be of steel underframe and steel draft rigging.

This limits the use of wood to unimportant parts of the underframe, such as intermediate sills and cross-beams, and to the superstructure of the car. In the case of open-top cars this means only posts and side and end plank and decking, but in box, stock, and furniture cars, etc., it means also siding, lining and roofing.

Steel vs. Wood for Open-Top Cars

To take up the question of open-top cars first, statistics gathered by operating officials of some of the larger railway systems seem to indicate that the cost of maintaining steel gondola cars over a period of years is greater than for composite (wooden and steel) cars of the same type. The data[1] collected show that all-steel gondola cars in their twelfth year of service cost over 36 per cent more to maintain than did the composite gondola. Of course, it is probable that during the first five years of its life the steel gondola cost less to maintain, but it is felt that taking the entire twelve years as an average, the cost would be more for the maintenance of the steel than the composite gondola.

It is furthermore interesting to note that but 60 per cent of the composite gondolas in service required repairs, while 72 per cent of the steel gondolas were obliged to be brought to the shops. The actual time that a car is in service and earning money for the road is an important consideration in determining its general utility. It is also interesting to note the conclusions in favor of the composite gondola, which are as follows:

The initial cost of the composite gondola with the present price of steel is less than the all-steel gondola.

The composite type of car costs less to maintain than the steel gondola.

The sides of the composite car do not bulge as do those of the steel car.

The records show that while the composite car costs more to repaint than the steel car, it does not require painting as frequently.

A large portion of the repairs to composite cars can be taken care of at other than steel-car shops.

Certain properties in coal cause corrosion to steel, and wood is not affected by them.

Table 1 shows the annual cost of repairing freight cars since 1908. It will be noted from this table that the cost of repairs per car has increased from $59.30 in 1908 to $80.30 in 1914, an advance of over 35 per cent. This higher cost

TABLE 1—ANNUAL COST OF REPAIRING FREIGHT CARS

Year	Number of freight cars	Cost of repairs per car	Ton-miles per $1 repair cost	1,000 ton-miles per freight car
1908	2,089,302	$59.30	1,762	104.5
1909	2,073,606	59.70	1,768	105.5
1910	2,135,121	65.60	1,821	119.5
1911	2,117,644	65.10	1,815	117.9
1912	2,140,687	65.50	1,858	121.5
1913	2,209,533	74.70	1,802	134.6
1914	2,263,015	80.30	1,565	125.8

is due, of course, to a number of factors, but it is felt that no small part of it is due to the use of steel, which requires a greater outlay for material and a higher cost to repair, owing to the fact that it takes longer to make like repairs on a steel car than on a wooden one. It must also be borne in mind that this higher cost is very largely due to the much rougher usage to which freight equipment is now subjected. In recent years the freight business of the railroads has grown enormously, and has necessitated the construction of gravity yards for switching, and the use of fewer switchmen per cars handled than in former years. This has resulted in severe handling of freight equipment, and is probably responsible to a greater degree than any other factor for the increased cost of repairs in recent years.

Steel vs. Wood for Closed-Top Cars

In the case of closed-top cars, such as, for example, stock, box, and furniture cars, there is but little doubt that under present railroading conditions the understructure should be of steel with a wooden superstructure. The steel understructure is required to withstand the shocks of service and to give rigidity and stability to the car, while the wood is desired to give lightness and general utility to the body. Some all-steel box cars are in use today, but their heaviness and the fact that nails and cleats cannot be used in them to brace and hold the lading, are strong factors against the use of this material. It has not met with favor with shippers generally and probably will not as long as wood continues to remain available. No material has yet been discovered which combines the properties of strength, lightness, availability, and ease of working such as possessed by wood, and until

*Abstract of a paper presented at the annual meeting, New York, December, 1920, of the American Society of Mechanical Engineers.

[1]Paper by Wm. Queenan, assistant superintendent of shops, C. B. & Q.

such a material is developed and made available, wood will undoubtedly continue to be universally used for the superstructure of freight cars.

The dead weight of cars is also an important factor in considering the cost of and earnings from freight haul. There is no doubt but what the excessive weight of the all-steel car has been one of the most deterrent factors to its general adoption in freight-car construction, and this fact, together with its lack of readily available repair parts and the large expenditure required to equip shops to efficiently handle all-steel equipment, has combined to retard and limit its use.

Graded Lumber in Car Construction

It seems pertinent to say a word at this time as to the grades of material required for the different parts of the body of the car. In the early days when the supply of wood in this country was thought to be inexhaustible, clear grades of wood were generally demanded by the car builders, and in the construction of new cars this is generally the practice at the present time, especially for car roofing and siding, sound-knotted stock being used for decking and lining. Some of the more progressive railroads, however, have gone a step further in recent years and many are now using sound-knotted stock for siding and roofing for repair and maintenance work. There is no doubt but what such a practice is economical and based on sound judgment, for certainly there is no necessity for using clear material for the repair of many classes of freight equipment, the life of which may not be in excess of seven to ten years. One large railway system which not only constructs its own cars but does repairing on a large scale, has adopted the following practice as to grades:

FOR NEW CARS

Siding	No. 2 Clear and Better Fir
Roofing (double board roof)	No. 2 Clear and Better and Select Common Fir
Roofing (metal-covered)	Select Common Fir
Lining	Select Common Fir
Decking	Select Common Fir

FOR REPAIR WORK

Siding	No. 3 Clear and Select Common Fir
Roofing	Select Common Fir
Lining	No. 1 Common Fir
Decking	No. 1 Common Fir

On this particular railroad the saving on this amended practice amounts to over $500,000 per year, and its economy is apparent.

As far as specifications for end sills, door and side posts, belt rails, etc., are concerned, practice varies widely among the various railroads. Some still insist on oak for such purposes, and others have gone to fir and pine. With the rigid steel underframe it is believed the use of soft woods is more justified than ever for posts and belt rail, but unless well protected with steel plates it is believed the use of oak end sills is still to be recommended. Oak and other hard woods are becoming more scarce and higher in price each year and it is felt that the general practice very shortly will be pine or fir end sills properly reinforced with steel.

Some Advantages of Wooden Cars

An important feature of car construction which is decidedly in favor of wood, is its general ease of working and adaptability to repair, and this is brought about not only from its qualities, which make it easy to cut, saw and shape, but also by its almost universal availability. We have been a wood-using nation for over a century, and artisans familiar with its properties and able to work it are always at hand.

It is also rather curious that the salvage value of wooden cars is greater than that of steel cars, and no one doubts this who has seen the two types of cars in a seriously wrecked condition. The wooden car may be quickly and easily repaired, while the steel car is only rehabilitated at a high cost, or for the most part is fit for the junk pile.

The Importance of Well-Seasoned Wood

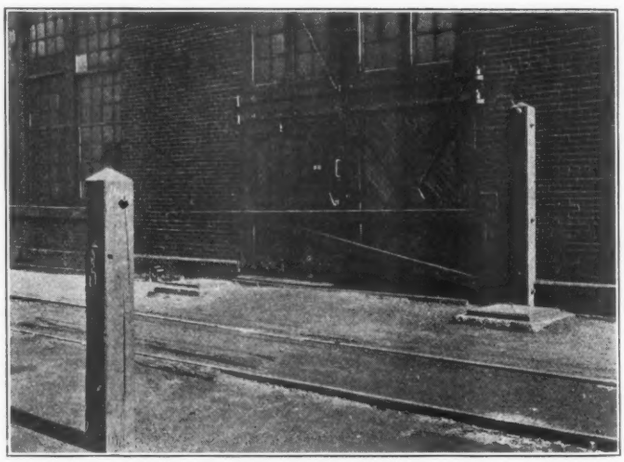
Before using wood in the building of freight cars it is vitally important that it be well seasoned. When our grandfathers built a house they expected it to last a century, and it usually did, for they took great care to properly season the wood before putting it to use. In the houses nowadays, however, we use wood almost before it is dry from the saw, and the result is that our American frame houses today are old at 15 or 20 years and we do not get anywhere near the service out of the wood that we should. Too often today we also see freight cars built of green lumber and timber, with the result that within a few months the bolts are loose, the wood having shrunk away from the original fastenings. This causes rapid deterioration and large timbers often quickly rot, particularly those containing sapwood.

It is safe to say that every railroad in the country should at all times carry on hand an 18 months' supply of oak and other hard woods and a 12 months' supply of fir, pine, and other soft woods. All this material when received should be properly piled for air seasoning, and in the case of clear material used for important parts, such as car siding, should be run through the dry kiln just prior to use.

Increasing attention has been given in recent years to the preservative treatment of certain parts of freight cars, and experiments have been made by some of the more important railway systems in the treatment of such items as stock-car decking, side and intermediate sills, roofing, etc. While these experiments have not been conducted for a sufficient length of time to determine actual results, the indications are that the preservative treatment of such car parts as are particularly liable to decay is profitable and will shortly be adopted as standard practice by the more progressive railroads. The conclusion is inevitable that the superstructure of freight cars will continue to be of wood as long as it is available at a reasonable price.

Shop Safety Gate

Many railroad shops are built upon such restricted properties that switching tracks are located close to shop buildings. This makes a dangerous condition when shop doors open out upon these tracks. To eliminate possible accidents,



A Simple, Effective Means of Preventing Accidents During Switching Operations

a safety gate has been devised by one shop which is chained across the door opening when the track is being used and similarly chained across the track during periods when not in service.

Designing Brake Heads for Uniform Shoe Wear

Principles Applicable to Heads Used On Wheels Revolving in One or Both Directions

BY H. M. P. MURPHY

ALTHOUGH the unequal wear of brake shoes is frequently caused by imperfections in the metals employed in their manufacture and also by the use of improper forms of suspension hangers for brake beams, one of the chief causes of this undesirable result is the incorrect location of the hanger eye and the brake beam socket in the brake head. In order to overcome the last mentioned evil and thus to obtain uniform shoe wear as nearly as practical conditions will permit, the following methods should be employed whenever possible in the design of brake heads.

Methods for Determining the Leading Dimensions of Brake Heads

For reasons which will appear later, two cases must be considered in the design of brake heads, one applying to heads used on ordinary railway cars which run equal distances in both directions and the other applying to "single end" locomotives and motor cars which run practically in one direction only. Before discussing these two cases, the general conditions and dimensions which will be employed must first be outlined. In Fig. 1, the standard A. R. A. brake head and shoe are illustrated. The line, *EF*, represents the middle radius, or center line, of the shoe, the arc, *MN*, represents the shoe surface when the shoe is half worn (the wear being assumed as uniform), and the point, *f*, represents the middle point of the average wearing surface of the shoe; these same designations will be used in connection with the subsequent sketches and descriptions. Moreover, in Fig. 2, *W* represents the wheel center, *R* represents the radius of the wheel and *C* represents the vertical distance between the center, *W*, and the point, *g*, of the wheel tread with which the point, *f*, of the shoe is to coincide; or, in other words, *C* represents the vertical height between the horizontal center line of the wheel and the average central point, *f*, of the shoe.

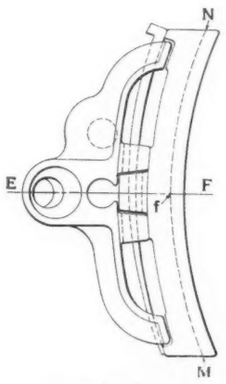


Fig. 1

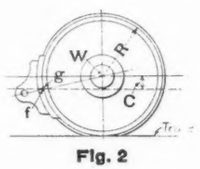


Fig. 2

The value of *C* as recommended by the Mechanical Division of the American Railway Association is approximately 3½ in. for cars. The symbols *C* and *R* will be employed hereafter to designate the dimensions indicated in Fig. 2.

CASE 1: *This case applies to brake heads to be used for wheels rotating equally in both directions.*

In order to obtain uniform shoe wear the following instructions should be observed: *The hanger eye* may be located at any point in the head providing that the hanger is of sufficient length to maintain an approximately constant angle with the center line, *EF*, Fig. 1, of the shoe, but as hangers are usually too short to produce this effect, the recommended location of the eye is directly on the center line *EF*, see Fig. 3.

The brake beam eye, or socket, should be located at some point on the line, *hk*, Fig. 3, the point, *h*, denoting the point of intersection of the center line, *EF*, and the center line of the hanger, whether the hanger eye be located as previously recommended or not. As indicated in the figure referred to the line, *hk*, is required to make the angle, *A*, with the center line *EF*, and it should be noted that this angle must be laid off towards the *top* of the shoe in every case, that is, the brake beam eye must be located on the line, *hk*, *above* the center line, *EF*, of the brake head. The value of the angle, *A*, depends on the radius, *R*, of the wheel and the vertical depression, *C* (see Fig. 2), of the central point, *f*, of the shoe. To determine the angle, *A*, when the values of *C* and *R* are specified, find the quotient of *C* divided by *R* and then refer to Table I, where the corresponding value of the angle, *A*, will be readily found.

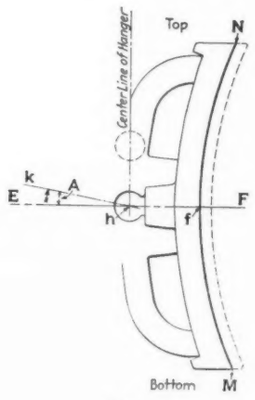


Fig. 3

Application of the Method

Example 1: To illustrate the method just described, let it be required to find the angle, *A*, which the line, *hk*, should make with the center line, *EF*, of the brake head (see Fig. 3) when the radius, *R*, of the wheel is 16½ in. and the vertical distance *C* (Fig. 2) is 3½ in.

Solution: To solve this problem divide *C* by *R* thus,

$$\frac{C}{R} = \frac{3.5}{16.5} = .212$$

By referring to Table I, it is seen that value of *A*, corre-

sponding to this value (.212) of C divided by R, is 12¼ degrees, that is, $A = 12¼$ degrees.

As the conditions of the preceding problem are those pertaining to the standard 33-in. car wheel and recommended location of the brake head, it is apparent that when the brake beam socket is located close to the hanger eye, the difference between the standard A. R. A. brake head, shown in Fig. 1, and that designed by making the angle A equal to 14¼ degrees is not of very great importance, but on the other hand if the brake beam socket is not located close to the hanger eye the difference may become quite worthy of consideration. The chief use of the foregoing method is, however, found in the case of "double end" locomotives where the distance C is often very great compared to R and, therefore, where the angle A has a correspondingly large value.

TABLE I

TABLE GIVING THE PROPER LOCATION OF THE BRAKE BEAM EYE IN BRAKE HEADS ON CARS AND LOCOMOTIVES IN ORDER TO PRODUCE UNIFORM SHOE WEAR

Value of Angle A, in Degrees, Corresponding to Various Values of C Divided by R

C/R	A	C/R	A	C/R	A	C/R	A
.0000	0	.0872	5	.1737	10	.2924	17
.0044	¼	.0915	5¼	.1779	10¼	.3007	17½
.0087	½	.0959	5½	.1822	10½	.3090	18
.0131	¾	.1002	5¾	.1865	10¾	.3173	18½
.0175	1	.1045	6	.1908	11	.3256	19
.0218	1¼	.1089	6¼	.1951	11¼	.3338	19½
.0262	1½	.1132	6½	.1994	11½	.3420	20
.0205	1¾	.1175	6¾	.2036	11¾	.3502	20½
.0349	2	.1219	7	.2079	12	.3584	21
.0393	2¼	.1262	7¼	.2122	12¼	.3665	21½
.0436	2½	.1305	7½	.2164	12½	.3746	22
.0480	2¾	.1349	7¾	.2207	12¾	.3827	22½
.0523	3	.1392	8	.2250	13	.3907	23
.0567	3¼	.1435	8¼	.2335	13½	.4067	24
.0611	3½	.1478	8½	.2419	14	.4226	25
.0654	3¾	.1521	8¾	.2504	14½	.4384	26
.0698	4	.1564	9	.2588	15	.4540	27
.0741	4¼	.1607	9¼	.2672	15½	.4695	28
.0785	4½	.1651	9½	.2756	16	.4848	29
.0828	4¾	.1694	9¾	.2840	16½	.5000	30

CASE 2: *This case applies to brake heads to be used for wheels intended to rotate in one direction only.*

In order to obtain uniform shoe wear the following instructions should be observed: *The hanger eye* should be located on the line, *fH*, Figs. 4 and 5, which makes the angle, *B*, with the center line, *EF*, of the brake head. This angle, *B*, depends on the *average* running speed of the car or locomotive and may be determined directly by aid of Table II. In all cases *B* must be laid off in the direction in which the contact surface of the wheel moves, that is, in the direction of rotation, as indicated in Figs. 4 and 5. The point, *H*, located on the line *fH*, having been fixed at any specified distance from *f*, should, of course, represent the center of the hanger eye, but if a long hanger is employed the eye may be located at some other point on the center line of the hanger providing that its distance from *H* is not excessive.

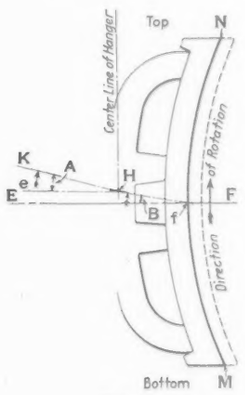


Fig. 4

Example 2: To illustrate the method of determining the angle *B* by aid of Table II, let it be required to find the value of *B* for a brake head to be used on the wheel of a "single end" car which has an average maximum speed of 30 m. p. h.

Solution: As the average running speed should be considered as one half the value of the average maximum speed,

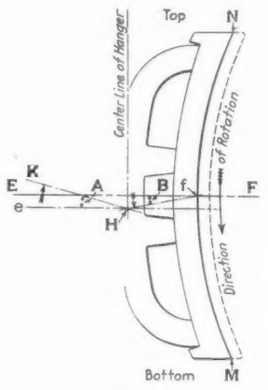


Fig. 5

the former, in this case, will be ½ x 30 or 15 m. p. h., whence by referring to Table II it is seen that the angle *B* should be equal to 12¼ degrees.

The brake beam socket or eye should be located on the line, *HK*, Figs. 4 and 5. To determine this line, *HK*, draw the line *eH* parallel to the center line, *EF*, of the brake head and lay off the angle, *A*, towards the *top* of the shoe in every instance, as indicated in Figs. 4 and 5. The angle, *A*, depends on the radius *R* of the wheel and the vertical depression *C* (see Fig. 2) of the central point, *r* or *g*, of the shoe, and may be determined by aid of Table I in the same manner as that employed in Case 1.

TABLE II

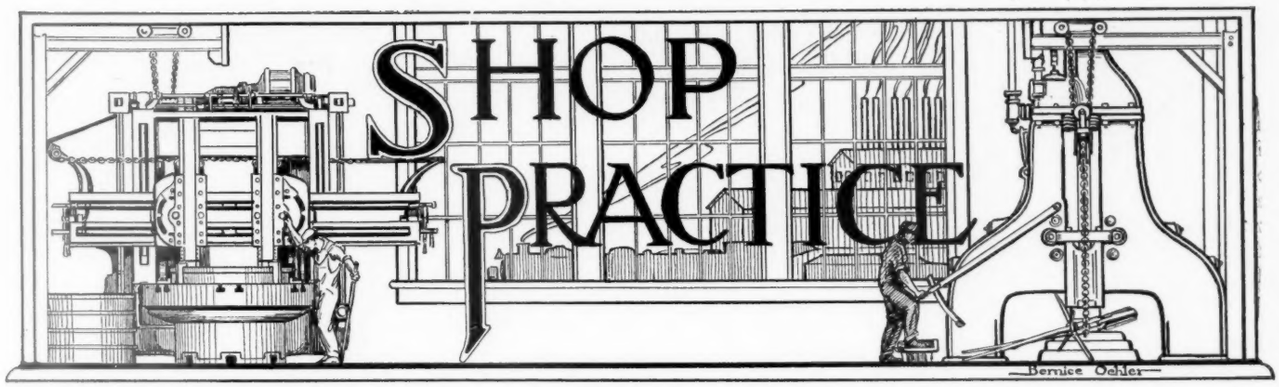
TABLE GIVING THE PROPER LOCATION OF THE BRAKE SHOE HANGER EYE FOR BRAKE HEADS, ON CARS AND LOCOMOTIVES ADAPTED TO RUN IN ONE DIRECTION ONLY, IN ORDER TO PRODUCE APPROXIMATELY UNIFORM SHOE WEAR

Average running speed in miles per hour	Values of Angle B in degrees	Average running speed in miles per hour	Values of Angle B in degrees
5	14¼	35	9¼
10	13¼	40	8½
15	12¼	45	7¾
20	11¼	50	7
25	10½	55	6½
30	9¾	60	6

Finally, it should be observed that, when the proper location of the brake beam socket (or eye) is specified as being "on a certain line," as *HK*, Figs. 4 and 5, or *hk*, Fig. 3, it must be understood that the line in question is to be the center line of the socket, that is, the socket must be constructed with respect to this line in the same manner as the socket shown in Fig. 1 is constructed with respect to the line *EF*.

TO SHOW UP minute cracks in hardened pieces, apply oil, wipe off, and chalk the surface. The oil appears at the cracks, soaking through the chalk.—*The Melting Pot.*

THE SHOPS, like other branches of the transportation system, were turned back to their owners in a bad state of demoralization, so that a great amount of work has been contracted for outside. It has actually been found both cheaper and quicker to reconstruct equipment in other than the railroads' own shops. Under political administration of the railroads a repair shop appears to have been a good deal of a loafing place.—*Providence Journal.*



Cylindrical Grinding in 1920*

BY W. H. CHAPMAN

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This paper comprises a study of the laws involved in cylindrical grinding and an analysis of grinding action (1) for draw-in cuts and (2) for traversed cuts.

Grinding efficiency is usually considered as (production) ÷ (wheel wear). Accordingly formulas are derived for wheel wear in terms of grain size of wheel, work speed, wheel speed, feed, etc. By calculating values for wheel wear for different conditions and comparing them with production figures calculated under the same conditions, a proper selection of wheels may be made.

The fact that wheel wear is a comparatively unimportant item in the total cost of grinding, however, frequently leads to wrong conclusions if this is made the controlling factor. The all-important factor is the rate at which the wheel may be made to cut and still not get out of truth. Assuming wheel cost to be, for example, 7 cents per cu. in. and other production costs 5 cents per minute, production efficiency is materially increased by increasing production at the expense of wheel wear within defined limits. The paper concludes with a series of practical conclusions, the most important of which is that increase of traverse speed increases production without increase of wheel-wearing action.

The author makes a mathematical analysis of grinding action for draw-in (non-traversed) cuts from which he derives the following laws of cylindrical grinding, operative *within the usual limits of speeds and dimensions.* For straight-in (draw-in) cuts a free-cutting wheel will wear according to the effect of wheel-wearing action as outlined below:

(a) Wheel-wearing action increases directly as: 1. Grain interval (grain size—inversely as grade). 2. Work speed (surface). 3. Square root of diametral cut (feed).

(b) Wheel-wearing action increases directly as the following are decreased: 1. Square of wheel speed (surface). 2. Square root of work radius.

A soft wheel is more susceptible to wheel-wearing action than a hard wheel and will more nearly follow the theoretical conditions. It is therefore more free-cutting and will cut more nearly the full chip than a hard wheel. There is consequently a gain in production as wheels of softer grades are used, all other conditions remaining constant, up to the point where the chips are geometrically perfect for a given condition of speeds and dimensions. It is clear from this standpoint that the softest possible wheel should be used. High wheel speeds up to the safe limit are of course necessary if the soft wheels are to perform in a satisfactory manner.

The Job of Being a Foreman

As a foreman what is your goal—the pay envelope or the satisfaction of getting team work and quality and quantity production from your department? Do you regard your work as a job or as a profession?

How much time do you give to thought and study with a view to improving the relations between the workers and the management? What do you know about production management?

These are plain questions and your answer to them will measure your worth to the railroad and in a larger sense to the community.

Is there a real reason why foremen generally in railroad service have been paid comparatively low rates?

Traversed Cuts

The most important development in recent grinding machines is the recognition and utilization of the fact that overall operating efficiency for traversed cylindrical work *increases as traverse speeds are increased.* (This assumes that for a given traverse speed, width of wheel and revolution of work are so related as to cause the cutting face to just cover the lead of the work.)

From another theoretical analysis the following laws of grinding for traversed cuts are deduced:

(*a*) Wheel wear increases directly with every increase in the work speed.

(b) Wheel wear decreases directly as the decrease in the quantity which we term "traverse factor," which is work speed divided by the square root of the sum of the squares of traverse and work speeds.

(c) Wheel wear decreases directly as square of wheel speed increases.

(d) Wheel wear decreases directly as the square root of the work radius increases.

(e) Wheel wear increases directly as the square root of the feed increases.

Production Costs

Grinding efficiency is usually considered as (production) ÷ (wheel wear). It is expressed as cubic inches of material removed per cubic inch of wheel wear. If wheel wear were

*Abstracted from a paper read at the December, 1920, annual meeting of the American Society of Mechanical Engineers.

the most important element of production cost, grinding efficiency might be considered on this basis without leading to the fallacy which exists today. As a matter of fact, the wheel cost is almost negligible compared to the other costs, and wheel selection should be based upon the production capacity of the wheel under the given set of grinding conditions, allowing the wheel wear to be as high as is necessary to get a free action without excessive wear (which would cause difficulty in sizing work and the need for frequent dressing). The all-important factor is the rate at which the wheel may be made to cut and still not get out of truth. This affects the grinding time, any reduction of which is of vastly more importance than an increase of wheel wear which may result from such a reduction.

The overall production efficiency of the machine based upon all costs involved is indicated by production-cost factors proportional to the earning rate of the machine.

In Table I the production-cost factors are given for 1-in. and 4-in. diameters of work only. The factors may also be expressed as earnings per unit of time, or the relative amounts the machine would earn in equal lengths of time under the various conditions as given.

Note that, due to high traverse, a 2.3-in. wheel which earns $3.68 in a certain length of time when grinding 1-in. work at low traverse and work speeds, will earn $10.62 in the same length of time when using the high speeds. If the widest wheel (7.35-in. face) be used the machine will earn $11.70 in the same length of time. The grade of wheel is suitable in each case according to the speed changes. This

Table I—Production-Cost Factors

Table speed, ft. per min.	Work, r.p.m.	Lead, in.	Diameter of work 1 in.	Diameter of work 4 in.
10.02	53	2.3	3.68	13.45
14.00	53	3.1	5.16	18.80
14.00	72.5	2.3	4.95	17.85
17.00	53	3.8	6.00	21.00
17.00	72.5	2.8	6.00	21.80
17.00	87	2.3	5.85	22.00
19.70	53	4.4	6.40	23.70
19.70	72.5	3.2	6.80	23.50
19.70	87	2.7	6.84	23.45
19.70	101	2.3	6.75	23.30
26.90	53	5.9	9.05	29.80
26.90	72.5	4.4	9.34	29.85
26.90	87	3.6	9.00	29.00
26.90	101	3.1	9.03	29.10
26.90	138	2.3	9.00	29.15
32.60	53	7.35	11.70	35.70
32.60	72.5	5.3	11.30	34.60
32.60	87	4.4	11.00	33.60
32.60	101	3.8	10.90	33.40
32.60	138	2.8	10.80	33.30
32.60	167	2.3	10.62	32.90

clearly shows that high traverse speeds cause a corresponding increase in earnings in spite of the necessary increase in work speed.

Considering the cost of wheels 7.35 in. wide as compared to wheels 2.3 in. wide, and the relative power required to drive the two wheels, it is very evident that the use of a harder wheel 2.3 in. wide would offset the difference in wearing action without greatly reducing production and that the production of the 7.35-in. wheel is matched by the production of the 2.3-in. wheel using highest traverse and highest work speed.

The most striking conclusion from the above is the fact that in order to use a narrow wheel and get great production the high work speed does not cause excessive wheel wear *due to the relief* on the wheel brought about by the *high traverse speed.* This traverse speed is also necessary to allow the rapid exposure of fresh work surface to the cutting face, making for a highly economical combination.

The author sums up the paper as follows:

In cylindrical grinding the following theoretical conclusions are found to hold true: Greatest grinding efficiency is obtained by the use of the softest wheels suited to the nature of the material ground. This efficiency is dependent upon the control of the dimension and speed relations between the wheel and the work so that the individual chip may have the minimum depth for a given volume determined by the maximum allowable radial depth of cut. This means long arc of contact, low work speeds and maximum feeds. With the above conditions established, *an increase of traverse speed increases the production without an increase of wheel-wearing action.*

Machine conditions must be such as to maintain as accurately as it is reasonably possible the speed and dimensional relations of the wheel and the work. This includes a great number of individual factors, any one of which may serve to entirely or partially impair the successful operation of the machine in following the theoretical fundamental laws as previously stated. It is worth while to emphasize some of the most important of these practical conclusions.

(a) The power drive must not allow speed variations unless under the wilful control of the operator.

(b) The wheel must be in good running balance and in absolute truth, and must be held in its position relative to the work within the closest possible limits.

(c) The work must be accurately held with respect to the wheel and must be uniformly rotated. Relative traverse between work and wheel must be uniform.

(d) The work must be rigidly supported over its entire length and no vibration allowed to occur between centers.

(e) The feed control must be sensitive and accurate and feeding must be at a rate such that the feed increment *never exceeds the maximum grain penetration,* which varies directly with grain interval, work speed, and square root of radial feed and inversely with wheel speed, and square root of work radius. (This is the most frequently violated of the factors involved.)

(f) The work must be kept at a uniform temperature and local heating prevented at all times. A copious supply of grinding compound should be directed to the arc of contact at all times. In truing the wheel with a diamond, the use of the cooling medium is vital to accuracy. Save the diamond by using a dresser to roughly true a wheel, and never feed a diamond over 0.001 in. per traverse.

(g) Select wheels intelligently, and do not try to use a single wheel for a variety of work sizes or materials unless the job is too short to warrant efficient grinding as compared with the time of changing wheels.

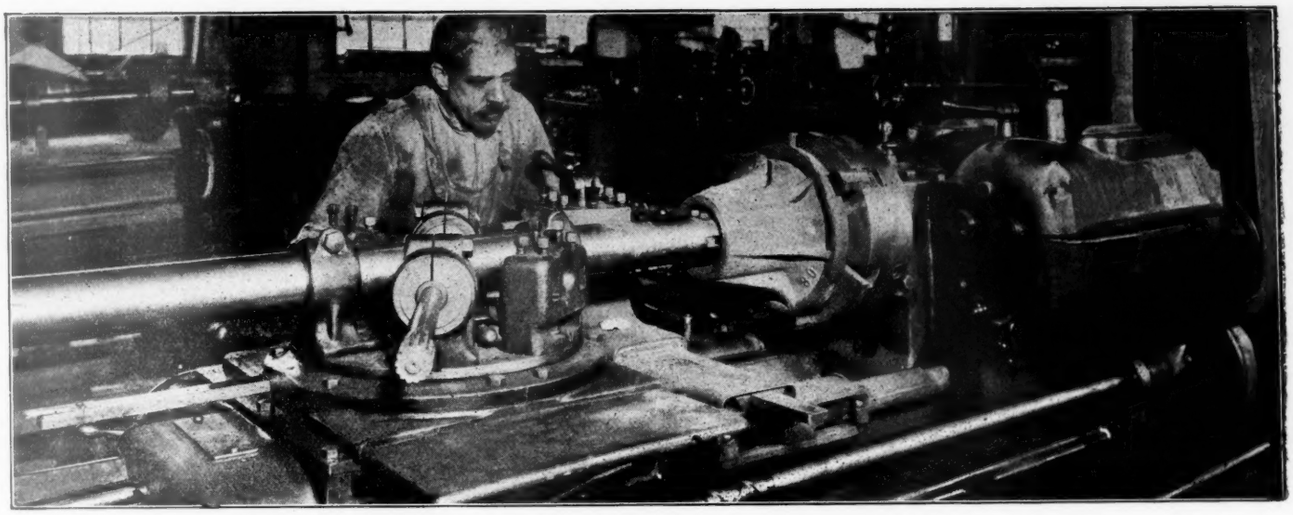
(h) An accurate finish requires the use of a soft, free-cutting wheel so controlled that the chips are very small. (Light feed and slow work speed with traverse to make the wheel face just cover the lead, should be used.)

(j) A burnished finish may be obtained by the peening action of a coarse, hard wheel trued dead smooth. Heating and inaccuracies of surface are likely to occur.

(k) Cases are rare where a wheel harder than grade M (Norton system of grades) may properly be used in cylindrical grinding. Low speed wheels, too small a wheel, too high a work speed and abusive feeding are usually the causes for the use of hard wheels.

(l) The contact of the wheel face with dry work at any time immediately ruins its value for finishing. The common practice of just touching the dry work when bringing up the wheel to contact is wrong, due to the charging of the wheel face with the uncooled chips (loading).

The Essential Requirements of tempering oils are: Flash and fire tests high enough to avoid serious evaporation loss or to incur high fire risk; comparative freedom from decomposition; absence of acid or acid forming substances, which would have a materially corrosive action on metals at high temperature; a fairly high heat capacity, and enough fluidity to permit rapid carrying away of the heat.—*The Atlantic Lubricator.*



Railroad Shop Turret Lathe Practice

The Turret Lathe; a Convenient and Efficient Tool for Accurately Machining Certain Locomotive Parts

BY HOWARD VOLZ

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THE machines referred to in this article are combination flat turret lathes and universal flat turret lathes with cross sliding turrets adaptable to bar or chuck work. The chief advantage of the machine equipped with a flat turret is its adaptability to any class of turning or boring operation and the simplicity of its arrangement. All the

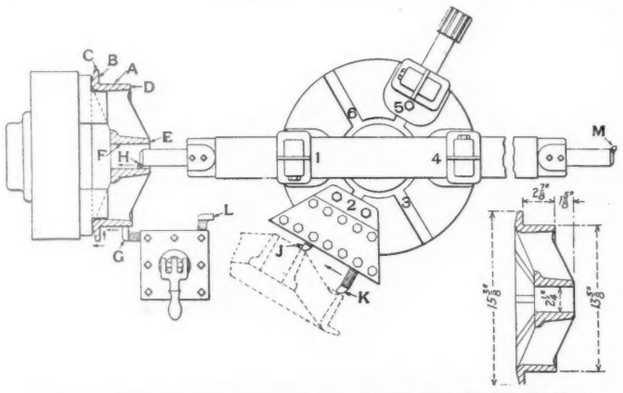


Fig. 1—Tooling Arrangement for Machining Valve Spider

tools are used to the full capacity of the machine. The side carriage with the four-way tool post or square turret is one of the main features of the universal flat turret lathe and this combination makes the machine practically universal for all turning and boring work within its range.

Another advantage is the ease with which a turret lathe equipped for bar work can be changed over to one arranged for chucking work or on the other hand a chucking machine changed over to a bar machine. The following examples are special railroad jobs but typifying the work that can be performed on these turret lathes. Illustrations of tooling equipment used in each operation are given, as well as a detailed description of the entire sequence of operations.

Main Valve Spider

The valve spider illustrated in Fig. 1 can be machined complete on a No. 3 universal turret lathe in one chucking. The operations consist of finishing surfaces *A, B, C, D, E* and *F*. The work is held in a three-jaw chuck with high jaws cut out to hold the spider on the inside of the rim. Surfaces *A* and *C* are rough turned and surface *B* is faced by cutter *G* held in the square turret. At the same time, hole *F* is rough bored by cutter *H* held in a cutter bar in one end of a 3 7/16-in. boring bar at the first turret position. Surfaces *D* and *E* are faced by cutters *J* and *K* held in a tool plate or multiple tool holder at the second turret position. Surface *A* is finish turned by cutter *L* held in the square

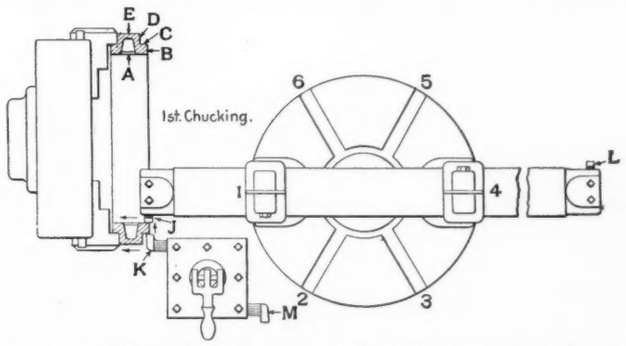


Fig. 2—Tooling of Universal Turret Lathe for First Operation in Machining Piston Valve Bull Ring

turret, and at the same time hole *F* is finish bored by cutter *M* in the cutter bar at the fourth turret position. Hole *F* is reamed by a reamer held in a tool holder at the fifth turret position, which completes all operations. Stellite cutters are used in the square turret. The time required is 12 minutes.

Piston Valve Bull Ring

Machining a piston valve bull ring in two chuckings on a

No. 3 universal turret lathe is illustrated in Figs. 2 and 3. In the first chucking surfaces *A*, *B*, *C*, *D* and *E* are finished. The work is held securely in a three-jaw chuck as shown in Fig. 2. Hole *A* is rough bored by a cutter *J* held in one end of a 3 7/16-in. boring bar at the first turret position. At the same time surfaces *C* and *E* are rough turned and surfaces *B* and *D* are rough faced by cutter *K* held in the square turret. Surface *A* is then finish bored by cutter *L* held in the opposite end of the 3 7/16-in. boring bar at the fourth turret position. At the same time surfaces *C* and *E* are finish turned and surfaces *B* and *D* are finish faced by cutter *M* in the square turret. This completes the operations to be performed in the first turret chucking. All cutters used are of stellite and the time required is 13 minutes.

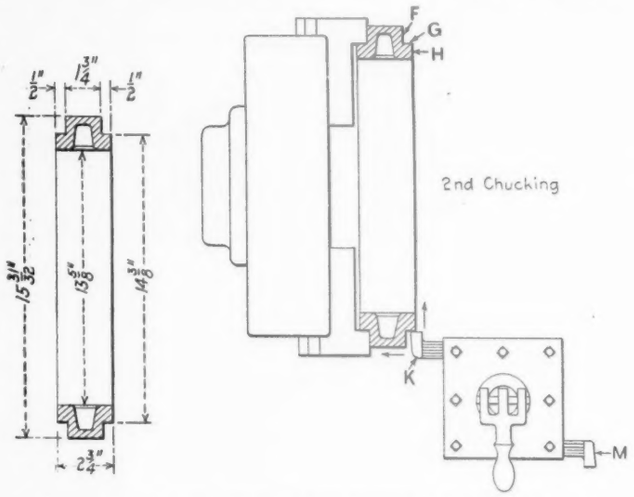


Fig. 3—Details of Bull Ring and Tooling Set Up for Second Operation

In the second chucking the work is held securely in soft jaws cut out to conform with the work as shown in Fig. 3 and the operations consist of finishing surfaces *F*, *G* and *H*. Surfaces *F* and *G* are rough faced and surface *H* is rough turned by cutter *K* held in the square turret. Surface *H* is finish turned and surfaces *F* and *G* are finish faced by cutter *M* held in the square turret. The work is removed from the chuck, all operations being completed. The time taken in the second chucking is 6 minutes, making a total time of 19 minutes required for machining the piston valve bull ring.

Exhaust Pipe Packing Ring

A packing ring for a low pressure exhaust pipe and slip joint machined on a 2¼ in. by 26 in. combination flat turret lathe with a cross sliding turret is shown in Fig. 4. The work is finished in one chucking and the operations consist of finishing surfaces *A*, *B*, *C*, *D* and *E*. A three-jaw chuck is used for holding the work on the flange diameter and the operations are performed in the following manner: (1) Hole *A* is rough bored by cutter *F* held in one end of a 3 7/16-in. boring bar at the first turret position. (2) Surfaces *C* and *D* are rough faced by cutters *G* and *H* and surface *B* is rough turned by cutter *G*, both cutters being held in a tool plate or multiple tool holder at the second turret position. (3) Surface *B* is finish turned by cutter *J*; surfaces *C* and *D* are finish faced by cutters *J* and *K*; and

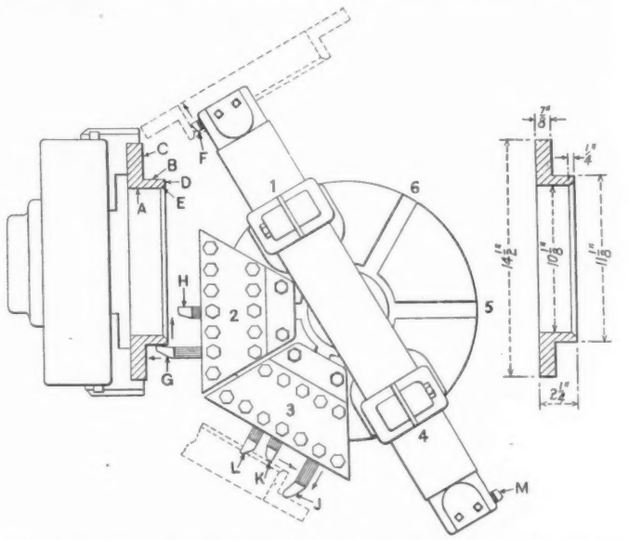


Fig. 4—Tooling of Combination Flat Turret Lathe for Machining Packing Ring

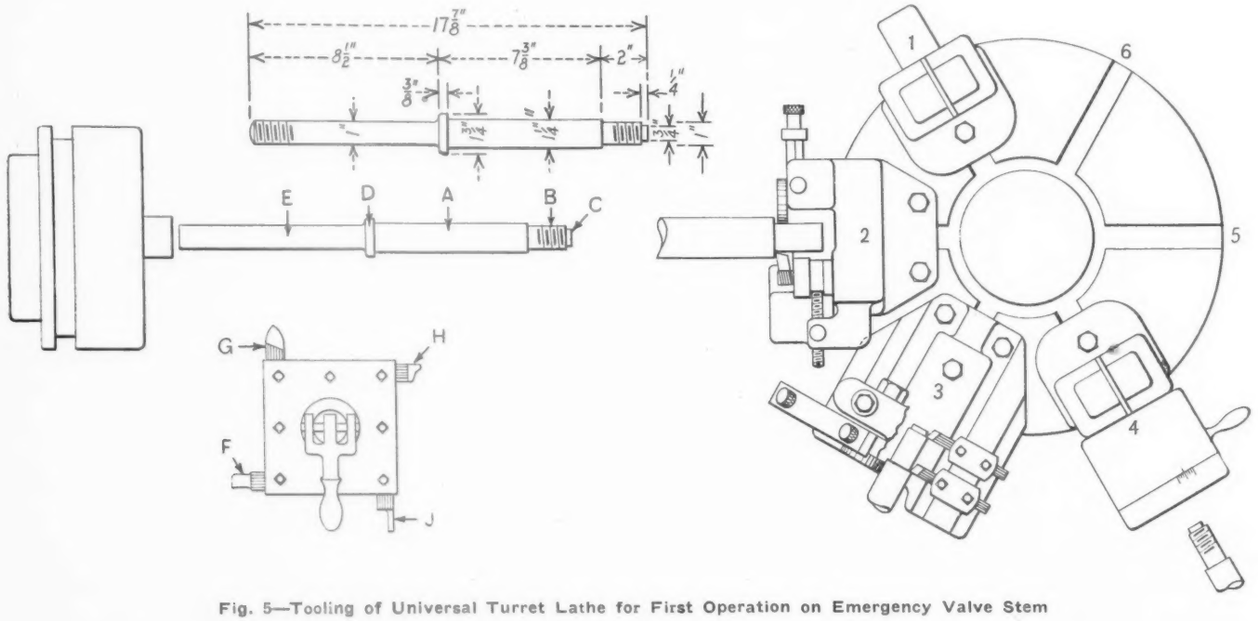


Fig. 5—Tooling of Universal Turret Lathe for First Operation on Emergency Valve Stem

surface *E* is formed by cutter *L*, all cutters being held in a tool plate at the third turret position. (4) Hole *A* is finish bored by cutter *M* held in the opposite end of the 3 7/16-in. boring bar at the fourth turret position. The time required to finish the work in the foregoing sequence is 12 minutes.

Emergency Valve Stem

Machining an emergency valve stem from a steel bar on a universal flat turret lathe is illustrated in Fig. 5. The following is the sequence of operations: (1) The stock is fed up to the bar stop held in the first turret position. (2) Surface *A* is turned by a cutter held in a universal turner at the second turret position. At the same time, cutter *F* held in the square turret is fed into the work preparatory to turning surface *E*, after which this surface is turned by cutter *G*, also held in the square turret. (3) Surfaces *B* and *C* are turned by cutters held in a multiple cutter roller rest turner at the third turret position. At the same time the corner of surface *D* is rounded by cutter *H* held in the square turret. (4) Surface *B* is threaded by a screw cutting die head at the fourth turret position. (5) The work is cut off by cutter *J* held in the square turret. The time required to finish the work in the foregoing sequence is 8 minutes. It requires two chuckings to finish work all over, the second chucking consisting of rounding the end and threading surface *E*.

Reducing Valve Stem

A reducing valve stem, as shown in Fig. 6, can be finished complete in one chucking from a steel bar on a 2¼ in. by 26 in. combination flat turret lathe equipped for bar work. (1) The stock is fed against the bar stop bracket. (2) Surface *A* is turned by cutter held in a universal turner at the first turret position. (3) Surface *B* is turned and end *D* is rounded by cutters held in a multiple cutter roller rest turner at the second turret position. (4) Surface *C* is taper turned by a cutter held in a taper turner at the third turret position. The taper turner is aided by a taper bar made to conform with the taper desired. The bar is held on a bracket which in turn is bolted to the head stock. (5) Surface *B* is threaded by a screw cutting die head held at the fourth turret position. (6) The corner of surface *E* is rounded and the work is cut off by cutters held in a slide tool at the fifth turret position. The time required to finish complete is 11 minutes.

Prosser Flue Expander

Machining a prosser flue expander from a steel bar can be accomplished in one chucking on a 2¼ in. by 11 in. hand screw machine in the following sequence of operations: (1) The stock is fed up to the bar stop held in the first turret position. (2) Surface *A* is turned by a cutter held in a universal turner bolted to the turret face at the second turret position as shown in Fig 7. (3) Hole *C* is drilled by a drill held at the third turret position. (4) Hole *B* is drilled by drill held in fourth turret position. (5) Contour *D* and groove *E* are formed by cutters held in a form block bolted on the front of the cut off slide. (6) Hole *B* is taper reamed by a reamer held at the fifth turret position. (7) Hole *C* is taper reamed by a reamer held at the sixth turret position. (8) The work is cut off by a cut-off tool held in an open side tool post bolted on the rear of the cut-off slide. All operations are completed in 7 minutes.

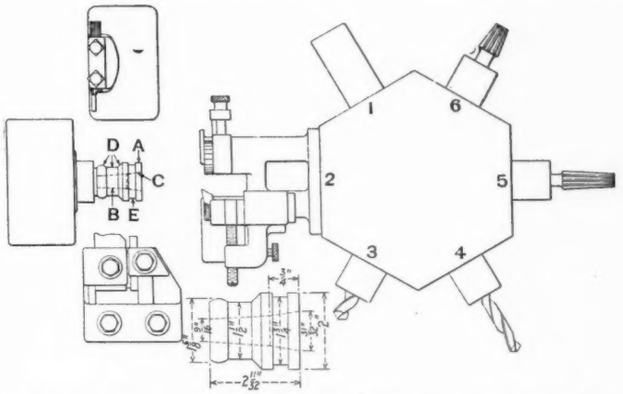
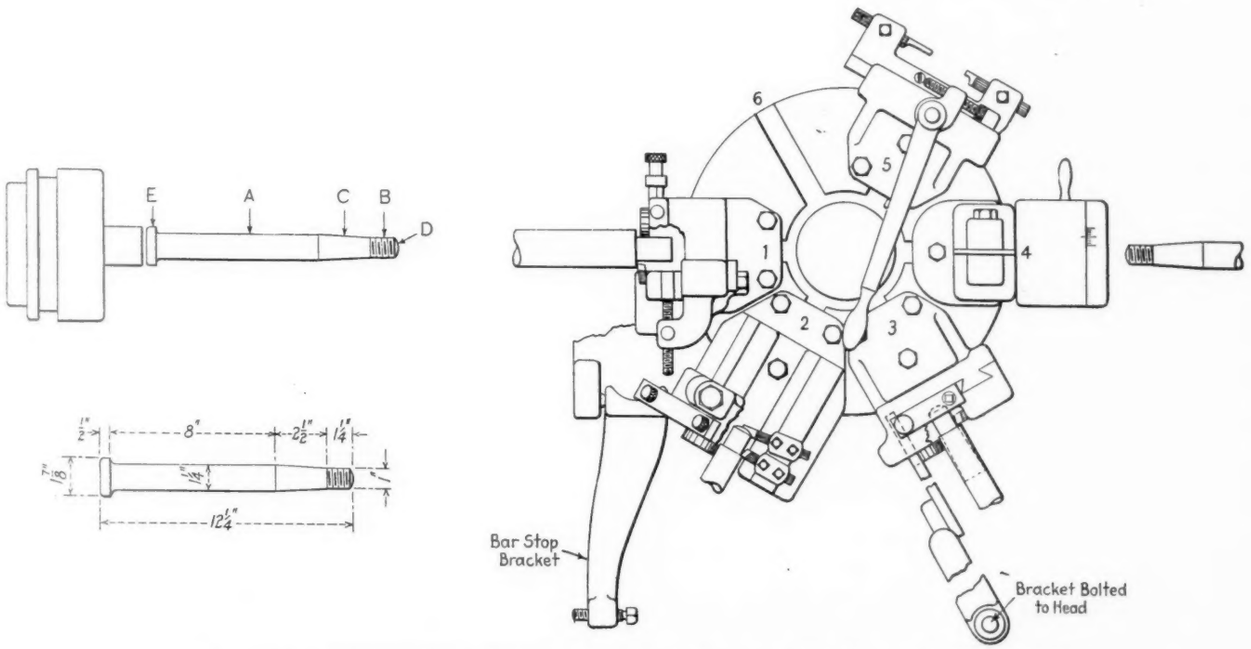


Fig. 7—Tooling of Hand Screw Machine for Making Prosser Flue Expander



6—Stem for Reducing Valve Machined from Steel Bar on Combination Flat Turret Lathe

The Reason Why Some Fusion Welds Fail*

Hardening Effect of Welding Heat Graphically Demonstrated and the Effect of Annealing Shown

BY T. D. SEDWICK
Engineer of Tests, Chicago, Rock Island & Pacific, Chicago

IN case of poor results from fusion welding shown either by laboratory tests or actual service, the inclination is to attribute such results to the material used, the method of making the weld, a poor operator, or the contributing effect of all three of these factors.

But there are other points that enter into the final results, and two of the important ones are as follows:

First—Was the metal in the casting or forging in such a physical condition that it was fit to be welded and afterwards give good service; did the metal originally fail on account of the presence of segregation of the various chemical elements; did it contain blowholes, porosity, or were there thermal stresses left from the original forging or casting operations; had the previous service fatigued the metal to the extent that it was inherently weak?

Second—Was the original metal adjacent to the weld deleteriously affected by the welding operation?

Some take the first mentioned factors into consideration, but I do not believe that very many, particularly the shopmen, give much thought to any action which may take place on the original metal. Tests and observations made on failed material and special test specimens have shown that welds fail although good conditions prevail in all other respects.

Investigation on various welds has shown that in the majority of the cases, especially in certain classes of material, the welding heat or the process of preheating has affected the metal in the sections being welded, causing a transformation of the physical structure of the steel, and in case of localized high temperatures the main body of the material absorbs the heat so fast that there results a quenching action on the heated metal. In the majority of instances the extreme hardening action will be localized near the surface immediately adjacent to the added metal. In some cases of preheating it has been shown that the high temperature causes a change in the physical structure of the metal, and while it is not usually so localized as in the case of the action of the welding heat alone, thermal stresses are set up in addition to those created by the heat of the welding process. These conditions have been found in material of thick sections where the heat would not be readily absorbed throughout the section and where the chemical content, especially the carbon, was such that it rendered the metal readily susceptible to structural changes, resulting in a hardened condition.

To illustrate some cases of this kind photographs have been secured showing several special tests and also some examples of failed material. A great many of these tests were made to demonstrate to the shopmen, that in the majority of the cases proper annealing should be done after the weld has been completed and that a thorough annealing would improve the physical condition of the metal, thereby causing it to render better service; this thorough annealing to be made by placing the metal in a furnace and giving it a soaking heat and then cooling it so that the whole mass could adjust itself to a uniform condition throughout.

The idea of causing a self or automatic annealing to take place by preheating is going at the proposition backwards and trusting to luck that we have not done more damage than good. It is necessary at times to preheat to take care of the shrinkage strains which might be set up in certain sections during the cooling after welding. What I am advocating is that after this has been done, we follow out a thorough annealing program. In this way any strain or hardened condition that has been set up by preheating, or by the welding heat, will be eliminated and we will then have a product the service of which will depend mainly on the quality of the material in the weld, and the perfection of the weld.

There are certain zones in any torch flame that are of a higher temperature than others, and as it too often happens that a sufficient length of time is not taken in preheating to permit a soaking heat, more or less locally heated areas are produced that multiply the thermal stresses not eliminated during the subsequent period of cooling.

In the majority of the shops, especially the larger shops, where special annealing furnaces have not been installed there are always some furnaces of sufficient size in which at least the smaller castings and forgings could be annealed and this annealing could be done at a comparatively low cost. At the close of the day, as space is being left unoccupied by the regular work of the shops, the welded material could be placed in the furnace and be annealed over night without any material increase in the cost of fuel. This plan would not check production of the regular work.

Too little attention is given to annealing in general even in cases where no welding is done. In reclamation plants where old material is re-worked, a worn out or failed forging will be reforged. When originally forged thermal stresses may have been set up in this material and not removed, or the material may have been overheated or even burnt. Later, during its actual service, fatigue stresses and unsatisfactory physical structure may have been produced. On reforging, further stresses may be set up and then without annealing to refine the grain and remove these stresses the forging will be returned to service. While it may give some service, if we had gone a little further and treated it properly, the extended service in my opinion would have been sufficiently great to more than justify any extra trouble or expense involved in a final annealing after forging. The same thought applies to welding of failed material.

There are a great many misconceptions of the process of annealing and a great many shopmen fail to observe the rule that it requires time for a piece of steel to adjust itself to the annealing temperature and be uniformly heated throughout. For instance, on one particular forging which the workman was instructed to anneal thoroughly he advised that he was doing so. But later it was found that he was simply sticking the forging into a blacksmith fire so that the welded area was buried in the fire. Under such conditions, while the extremely localized, highly affected areas will be removed, minor stresses will be set up back along the forging. To do the job right the forging as a whole should have been subjected to the annealing heat.

With such methods it is hardly fair to expect 100 per cent service out of material to which we have added or in which we have produced unsatisfactory conditions rather than reduced them. I am not looking at this matter from a strictly theoretical standpoint; the tests and the various failed material which have come to our attention justify these remarks. In a great many cases the only reason that a new forging may give good service is because the designer has allowed

*From a paper read before the American Welding Society, Chicago Section, December 22, 1920.

for such a great factor of safety that the shopmen can do almost anything with the material and there will still be some service left. Assuming that a designer had originally made provisions for a factor of 10 and later the section was broken and welded, this weld in reality may have a factor of five. The designer attempts to take into consideration not only the ordinary service requirements but abnormal require-

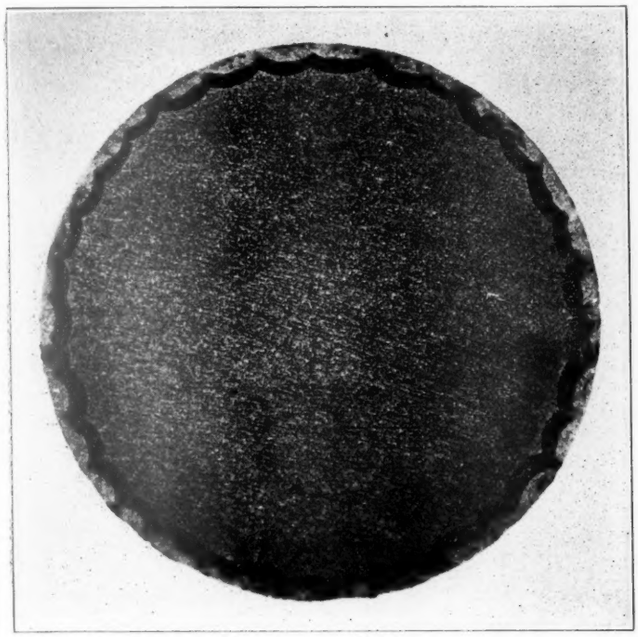
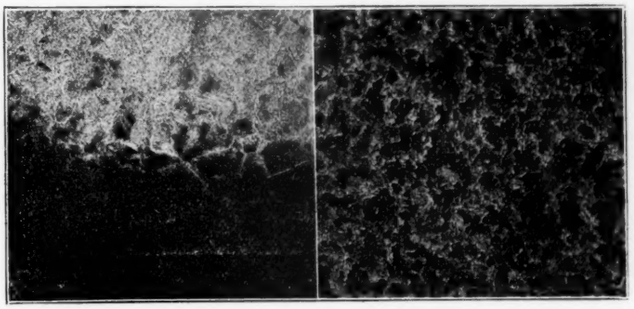


Fig. 1—Etched Cross Section of a Failed Piston Rod; the Crosshead Fit Had Been Built Up by Electric Welding

ments that the material might need in case of emergency. If we have reduced this factor 50 per cent, the material might be able to go along in ordinary service with safety but for the emergency cases we may have eliminated the safety margin entirely. Sometime during the life of the material, it is going to run into extreme conditions. Then, if we have not taken the proper precautions, it will fail. Even where the welder has increased the cross-sectional area the failure can be traced to some of the conditions mentioned above.

The photographs were taken in connection with some of the tests already mentioned, to illustrate the zones affected by the heat and the hardening effect of the welding operations. The method of bringing out visibly these hardened areas or structural differences without magnification involves the same procedure that can be used in checking the extent of the hardened or tempered areas in tools, such as chisels, hatchets, etc., and is comparatively simple. The surfaces are given a rough polish and dipped in nitric acid of specific gravity 1.13, or where this is not practicable the acid may be poured over the steel.

The hardened areas referred to, in a great majority of steels will correspond to the hardness that would have been produced had the steel been heated and quenched. In some of the tests illustrated strips were taken from the specimens so as to embody metal from the extremely hardened zones only, and then from adjoining positions progressing successively into the unaffected metal. It was found that in the zones where the hardened condition was highly localized these strips would not bend over 15 deg. before breaking or snapping off, but after annealing they could be bent flat on themselves, the same as the original metal.

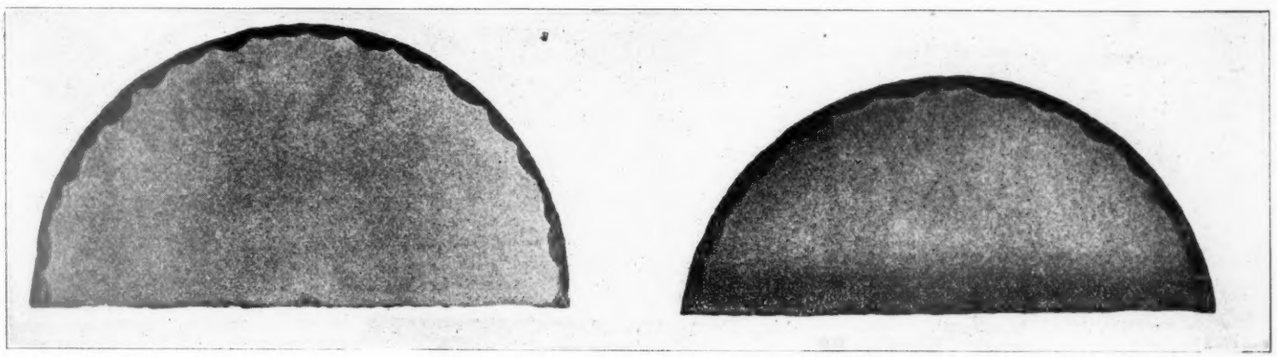


(a) (b)

Fig. 3—Microphotographs of the Metal in the Piston Rod Before Annealing; (a) the Added Metal and the Heat Affected Area; (b) Normal Structure at Center of the Rod

A failed piston rod on which the cross head fit had been built up by the electric welding process is shown in Fig. 1. The photograph shows the added metal on the outer area around the circumference and between this and the interior metal in the rod is a scallop-shaped area affected by the welding heat. This represents the condition of the metal in the rod at the time of the failure. The average scleroscope hardness of the added metal was 49, of the heat affected area 80, and of the metal in the rod proper 50.

The face of the same cut opposite to Fig 1 was cut in two and both pieces annealed, one-half being allowed to cool in the furnace and the other half in the air. It will be noted in Fig. 2 that the hardened area between the added metal and the parent metal has been eliminated in both cases.



(a) (b)

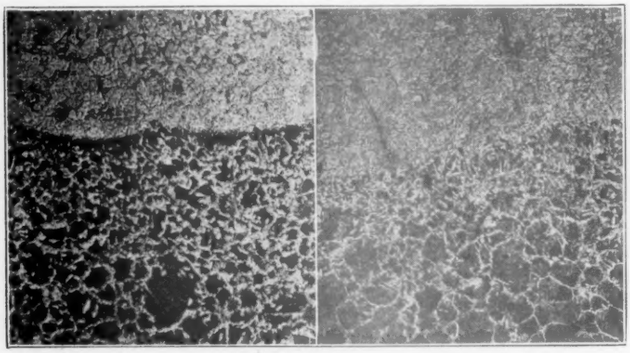
Fig. 2—Two Halves of the Face Opposite to That Shown in Fig. 1 After Annealing; (a) Cooled in the Furnace; (b) Cooled in the Air

The scleroscope hardness of the added metal in the piece cooled in the furnace was 38 and of the metal in the rod, 55. The scleroscope hardness of the added metal in the piece cooled in the air was 38 and of the metal in the rod, 57.

The fact that the added metal in these two photographs is shown in black should not cause it to be confused with the darkened area on Fig. 1 as in the latter two cases this was a matter of etching to differentiate between the added metal and the metal in the rod proper.

Fig. 3 shows microphotographs of the metal in the rod

before annealing; *a* shows the added metal and the heat affected area in the rod, *b* the normal structure in the center of the rod, all at a magnification of 100 diameters. Fig. 4*a* and *b* are the microphotographs (100 diameters) of the two annealed pieces shown in Fig. 2. Both were annealed for



(a) (b)

Fig. 4—Microphotographs of the Two Pieces Shown in Fig. 2, After Annealing; (a) Cooled in the Furnace; (b) Cooled in the Air

three hours at 1,500 deg., F., after which *a* was cooled in the furnace and *b* in the air.

Both show the added metal and the structure in the rod proper, the heat affected area having been eliminated by the annealing process. There is less segregation of the ferrite

Fig. 5—Example of the Effect of Erratic Action by the Operator on the Uniformity of Heat Penetration

around the grain boundaries in the piece cooled in the air than in the one cooled in the furnace.

As a further illustration of the variation of the hardened zone, Fig. 5 is an etched cross-section of another piston rod on which the cross head fit had been built up, the rod originally being heat treated Nichrome steel. Attention is called to the variations in the area of this hardened zone in the parent metal. On comparison with the first rod shown,

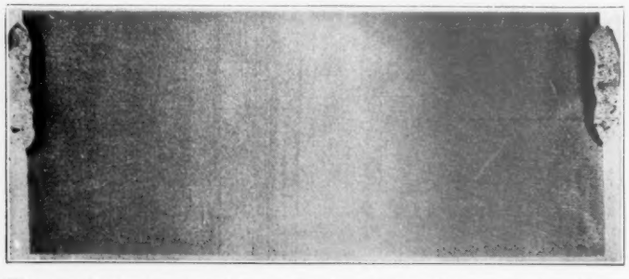


Fig. 6—Hardening Effected by Adding Metal Without Preheating—Electric Arc

an unusually uniform movement and metal application by the welder is evident. It has occurred to me that an etching method similar to this might be adaptable for grading or examining welders as to their proficiency as well as for giving some indication as to the condition under which they were working.

The next few etched sections were made in an investigation to determine if a system of preheating could be developed to eliminate the hardened zones or heat affected areas created either through the preheating or the welding heat.

Fig. 6 is a crank pin, on which no preheating of any kind

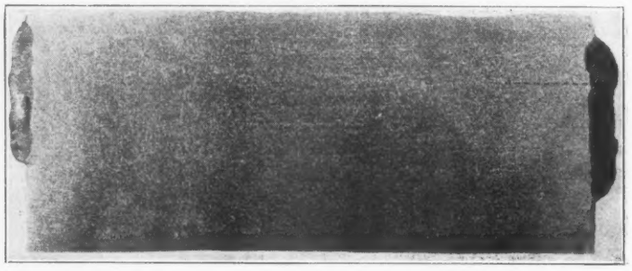


Fig. 7—The Hardness Removed by Annealing

was done. The scleroscope hardness on the added metal was 33, on the hardened zone 58, and on the rod proper 46. The metal was added with an electric arc. Fig. 7 shows the previous piece after annealing, the added metal showing a hardness number of 34, and the pin metal proper 45. Fig. 8 is a piece of crank pin steel to which the patch was made after preheating the parent metal with the arc, resulting in the

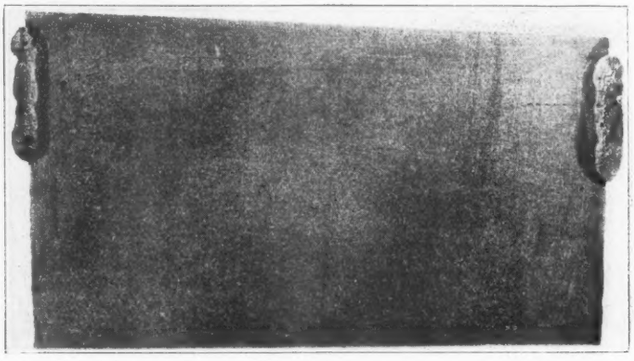


Fig. 8—Metal Added After Preheating with the Arc

hardness numbers of 35 in the added metal, 50 in the hardened zone, and 47 in the rod. The metal was added with the electric arc. After annealing, the hardened zones were removed; the hardness number in the added metal was 35 and in the rod 45.

Another piece of the pin was preheated in the blacksmith

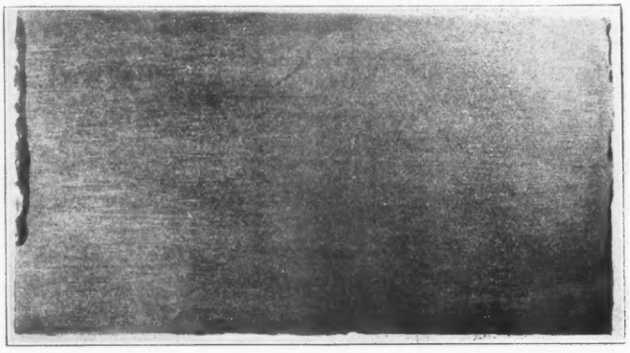


Fig. 9—Hardness Produced by Preheating with the Arc—No Metal Added

furnace and metal added by the electric process; in this case the hardness number in the added metal was 34, in the

hardened zone of the pin 59, and in the body of the pin 46. After annealing, as in the previous instances, the hardened area was eliminated, resulting in a hardness number in the added metal of 34 and in the rod of 45.

Fig. 9 shows a pin which was preheated with the arc, but no metal added, resulting in a clearly defined hardened zone with a hardness number of 64, the body of the rod showing 44. After annealing of this piece the hardness was uniformly 45 out to the edge of the piece.

Metal was added around the section of a locomotive frame with the electric arc, without preheating. The metal was added in three layers with the idea that the succeeding layers might exert an annealing action on the affected area. The hardness number in the added metal was 34, in the affected area 57, and with the parent metal 47. After annealing this piece the affected zone was removed. The same frame member was preheated with the electric arc and metal again added in three layers, as in the former case, without showing any improvement in the hardening effect of the welding heat.

Attention is called to the extension of the action of the arc ahead of the added metal, which may be observed in these photographs. It will be noted that the hardened zone extends about the same distance in front and back of the points where the welding operation starts and stops as it does beneath the weld. In a great many cases, in fact in the majority, it appears that a fracture will start by an initial check through the affected zone immediately back of or in front of the added metal, although there have been cases that unquestionably were a detail fracture starting from the area underneath the added metal. Fig. 10 is a piston rod which was preheated with the oxy-acetylene torch, no metal being added. The heat affected area is shown by the shaded zones, with a maximum hardness in the affected zones of 53, whereas the normal hardness in the rod was 44. After annealing, this piston rod showed a normal hardness of 45 throughout the rod section.

In the case shown in Fig. 11 the piston rod was preheated according to the regular practice and metal added by the oxy-acetylene process, producing the affected zones shown. The hardness of the added metal in this case was 32, in the affected zones 53, and in the rod proper 44. On annealing this piece the affected zones were removed; the added metal then showed a hardness of 34 and the rod 44. Fig. 12 shows the same affected zones when the metal was added by the oxy-acetylene process without preheating. The added metal shows a hardness of 32, the affected zones 53, and the body of the rod 42. On annealing, the affected areas were eliminated, resulting in a hardness number in the added metal of 35 and in the rod of 45.

A worn tire flange, with an original scleroscope hardness over the section averaging 49.2, was built up by electric welding. Before annealing the added metal had a hardness of 18, the hardened area of the original metal 67 and the body of the flange 48. After annealing, the hardness of the added metal was 20, that of the affected area 46 and the body of the tire 48.

The average of several transverse tests on pieces of rail in

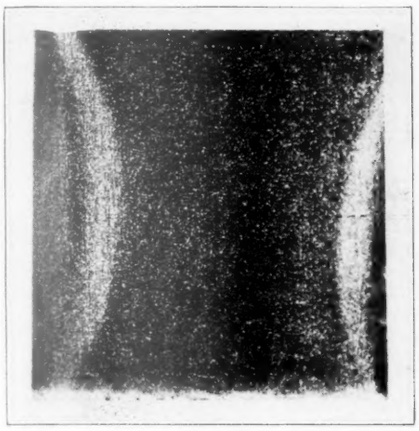


Fig. 10—Hardening Effect Produced by Preheating with Oxy-Acetylene Torch —No Metal Added

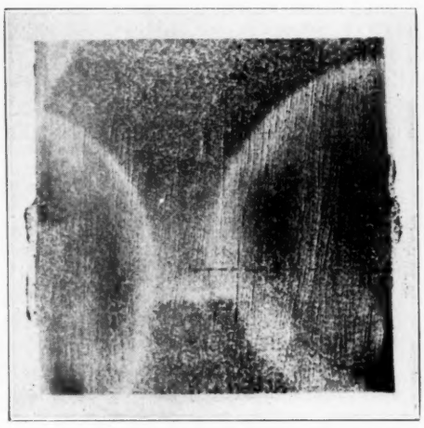


Fig. 11—Hardness Produced by Adding Metal with Oxy-Acetylene Torch After Preheating According to Regular Practice

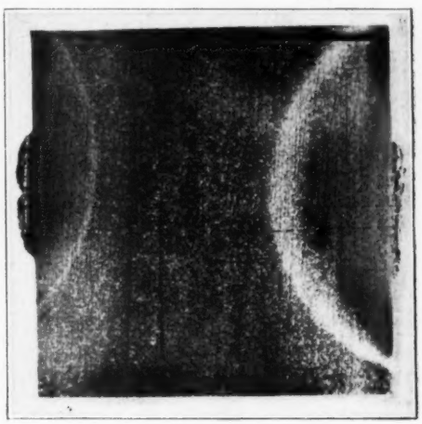


Fig. 12—Affected Zones Caused by Adding Metal with the Oxy-Acetylene Torch Without Preheating

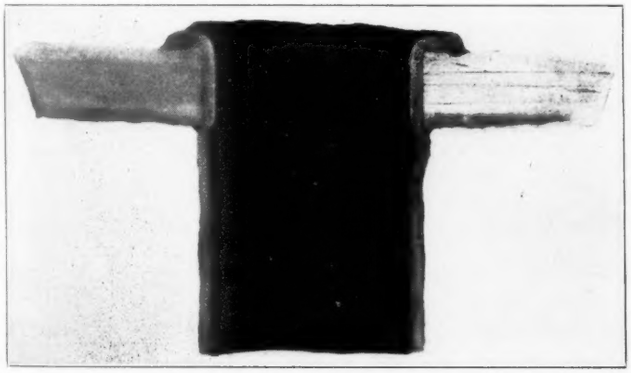


Fig. 13—Etched Section Through a Boiler Tube Welded to the Sheet; Metal of the Sheet Unaffected

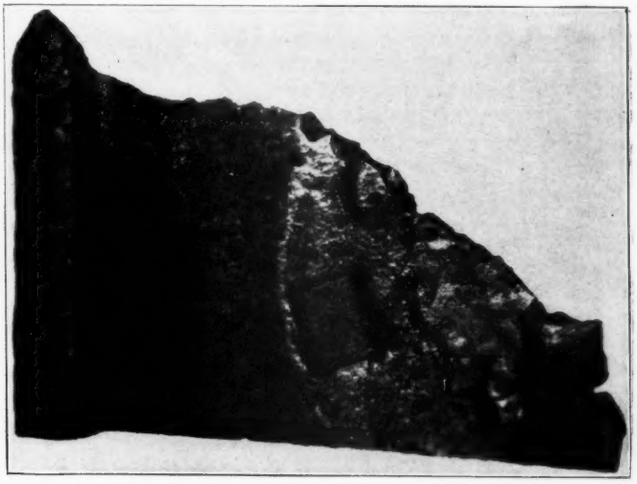


Fig. 14—Example of Metal Too Poor to Weld

which bolt holes were drilled, showed an average depreciation of the transverse strength of about 25 per cent as compared with the solid section. Where these holes were cut with the acetylene flame, this depreciation was 38 per cent.

The photograph, Fig. 13, of the boiler tube welded in the plate and then etched, does not develop the highly affected zones shown in the previous views. In this particular case the hardness number of the plate was 45, in the tube 50, and in the added metal 45. Even if the welding heat did cause unsatisfactory conditions along the lines in question, the service conditions would in themselves constitute more or less of an annealing process.

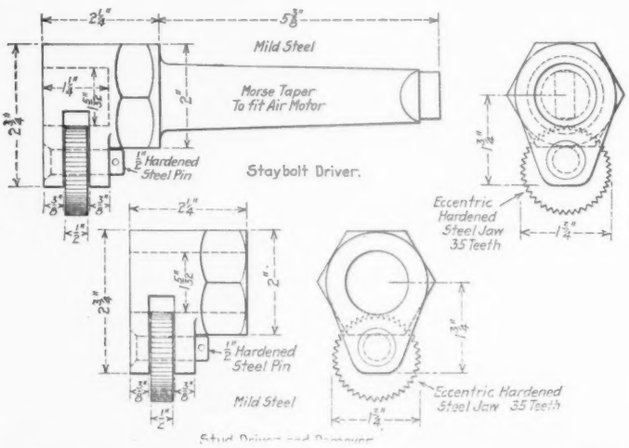
Fig. 14 is a piece of a member of a truck side frame which had been welded with the acetylene flame. It shows an unusually large area affected by the preheating and welding heat, particularly the white zone about the center of the section, which showed a penetration through the entire section. The metal is excessively porous and this casting should, in my opinion, never have been welded unless it was possible to cut away this area entirely.

I do not want to leave the impression that all welds fail on account of the structural changes due to the heating, or that I am advocating not doing any welding at all, or that I am in favor of any one particular process of welding. All the various methods of welding have their proper fields, and a great deal of profitable work can be done with them. However, if the points mentioned are taken into consideration by the party laying out the welding work, our welds will show fewer failures.

Stay-bolt and Stud Driver and Remover

BY F. OSBOURNE

It is the practice in some railroad shops to square the ends of stay-bolts for the purpose of driving with a box wrench or chuck driven by an air motor. This means that stay-bolts have to be squared in a forging machine or by some other method. The use of the devices, illustrated, eliminates the need for squared ends, thus saving a considerable amount of time and labor. The stay-bolt driver will drive 1-in., 1 1/16-in. and 1⅛-in. stay-bolts. If a bolt does not fit properly, it can be taken out with this driver by moving the eccentric steel jaw to grip the bolt, then reversing the motor.



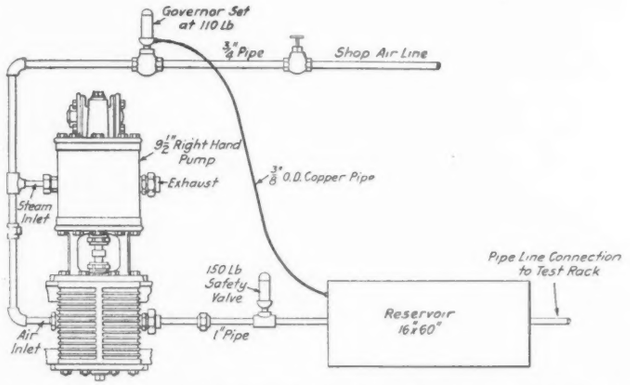
Tools for Driving Studs and Staybolts Without Squared Ends

Part of the stay-bolt driver is made hexagonal to fit a wrench and the other part is made a standard Morse taper to suit an air motor spindle. To use as a stud driver or remover, the device is made up without a Morse taper shank and has a hole bored through the driver. This will allow the eccentric jaw to grip any part of the stud and a wrench may be used. The stud driver shown will drive in or will remove old studs ¾ in., ⅞ in., 1 in. and 1⅛ in. in diameter.

High Pressure Pump for Air Test Rack

BY C. E. YOCUM

The piping arrangement shown in the sketch furnishes a simple means of increasing air line pressure to practically twice its normal value for testing feed valves, brake valves, etc. Air from the shop air line enters the pump at the steam inlet and also at the air inlet. If the pump is on either the upward or the downward stroke the shop line pressure is working on both the steam and air pistons. If the shop air line carries 90-lb. pressure this will give a maximum of 180 lb. per square inch. The governor may be used as shown and any desired pressure carried in the reservoir.



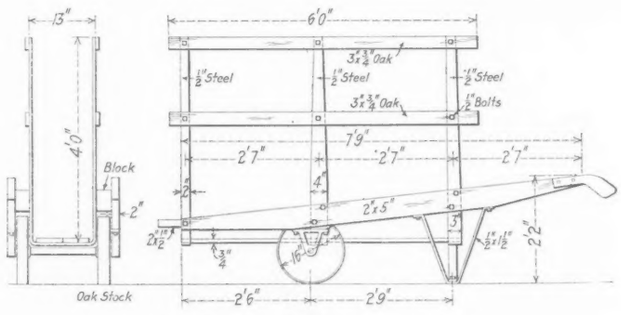
Pneumatically Operated Pump for Supplying High Pressure Air

Truck for Handling Jacket Iron

BY A. G. JOHNSON

Mechanical Engineer, Duluth & Iron Range, Two Harbors, Minn.

When the jacket is removed from a locomotive in the back shops, and is sent to the jacket shop for repairs or to be stored out of the way of other workmen, its removal and handling has always been a disagreeable, inconvenient job. This difficulty in handling can be overcome to a large extent by means of a special truck construction, as illustrated, at a small expense in each local shop. A shop truck is used as the foundation and high sides are provided, open at both ends. The sides consist of a frame-work of iron strips which may be riveted or welded at the joints. This truck will hold the entire jacket from one locomotive and enable it to be moved easily from place to place as desired.



Truck for Handling Jacket Iron

An English Locomotive Repair System*

An Outline of the Methods Followed by the Lancashire & Yorkshire in Putting Engines Through the Shop

BY COL. H. E. O'BRIEN
Assistant Mechanical Engineer, Lancashire & Yorkshire, Horwich, England

ENGINES are stopped at engine houses on the recommendation of either the boiler inspector or locomotive district superintendent, and the receipt of a waybill at the shops is a notification that repairs are required to such engine.

The waybill is filled in in duplicate, by the locomotive district superintendent and forwarded by him to the shops with a tubeplate diagram and a boiler stay chart.

The inspection department, when calling such engines into the shops, pay due regard, after conference with other departments concerned, to:

(a) Particular type of engine most urgently required by running department, varying with the season.

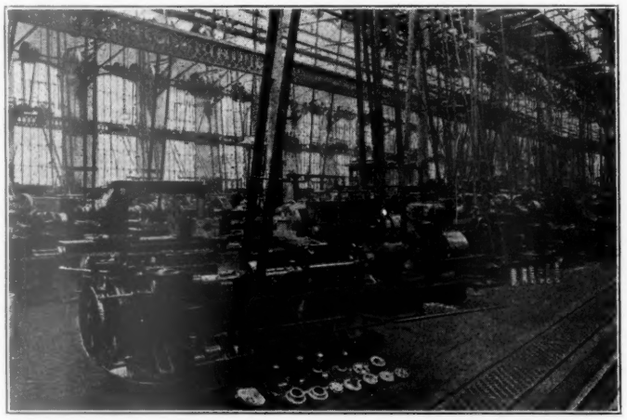
(b) Ability or convenience of the repair shops to deal with such repairs as may be required.

Light repairs are generally dealt with at once.

Waybills

Upon receipt of the waybill at the shops the duplicate is sent to the inspection department.

The waybill is a four-page sheet; on the front outside is



A Group of Automatics at the Horwich Shops of the Lancashire & Yorkshire

stated the number and class of engine, the engine house to which it belongs, date stopped for repairs, experimental fittings (if any), flaws, date of last general repair, mileage since last repairs, mileage of tubes and crank axle, also additional remarks.

The first inside page provides a list of main items such as frames, pedestal jaws, wheels, axles, tires, axleboxes, cylinders, valves and valve gear, etc., for the engine and for the tender, with space for remarks.

The second inside page includes boiler fittings, boiler and tender tanks and coal bunkers.

The back, or fourth page, provides space for shop remarks upon details of repairs effected while the engine was in the shop, such as:

(*a*) Date left shop.
(*b*) Whether boiler had been out of frame.
(*c*) Cylinders out of frames.
(*d*) Experimental fittings, also boiler pressure, registered number of boiler, thickness of firebox side, type of valve and thickness of valves.

*Taken from a paper read before the Institution of Locomotive Engineers, England.

The bottom portion of this page also provides a space in which the engine house foreman can record the behavior of the engine in traffic during the first six days after receipt from the shops.

When the latter space is filled in, the waybill is returned for the shop superintendent's information and provides ground for exercising disciplinary methods in regard to the shops concerned.

Calling in to the Shops

The number of engines called in weekly depends upon the weekly output of repaired engines.

The number of engines of any one type standing at engine houses awaiting repairs is not allowed to exceed 10 per cent of that particular class.

A forecast of the engines likely to be sent into traffic during the following week is made, based on the above premises, and an equal number of engines are called in from the engine houses.

As far as possible, such engines are called in from particular engine houses as will permit the drivers and firemen of the outward-going engine bringing back with them one of the engines called in for that week, a considerable item in wages thus being saved.

Inspection Prior to Repair

Upon receipt of an engine at the shops for repairs an inspection is made while the engine is still in steam if possible.

This examination includes trial of injectors, whistle, steam sand and cylinder cock gear, cylinders and valves, ejector and boiler mountings in general, also tenders and tanks for leakage, etc.; any items missing are noted, and the brake cylinders and pipes are tested.

Where any of the items are found to be in good order the inspector marks the waybill to that effect.

At the end of the inspection the fire is dropped, tenders and bunkers are emptied of coal (this being transferred to engines coming out of the shops), and the engine is placed in a loop to await a vacancy on the stripping pit.

Stripping Pits

The method of dealing with engines on the stripping pits is as follows:

While fitters are uncoupling the motion and wheels, laborers are emptying the smokebox, taking grate bars out, brick arch down, and sweeping the firebox sides so that as soon as the ashpan is dropped the boiler examiner may examine the firebox.

During the stripping the chargehand stripper thoroughly inspects all parts and decides what bolt renewals are needed in cylinders, pedestals, etc., spring brackets to be cut off for bushing, and his report is added to the waybill sent to the erecting pits.

Heavy repairs (which alone are dealt with on the stripping pits) are, in accordance with the boiler inspector's report, subdivided into the following classes:

Class A.—Engines which have no large structural defects with the boiler and firebox in such condition that they can be repaired in the frames. All repair work for this class of repair should be dealt with as expeditiously as possible as it will be required back again to the engine in 18 days.

Class B.—Cases where the boiler has to be lifted and can be repaired in

erecting shop upon the boiler pit or can be supplied with a spare boiler. This also applies to cylinders.

The work for this class of repair has to be returned to the engine within 21 days.

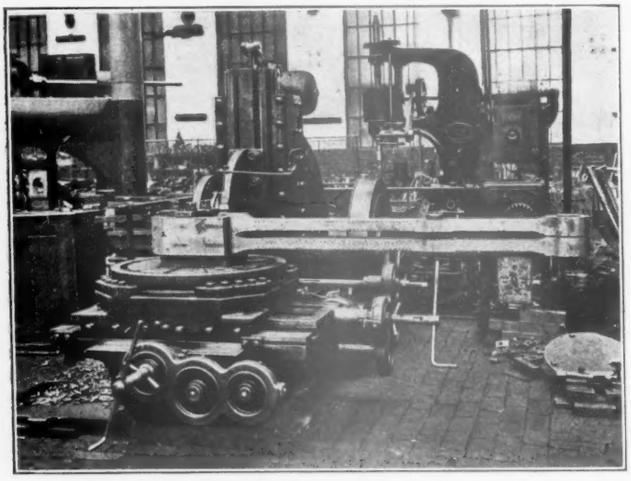
Class C.—All cases of heavy structural repairs such as cylinders, etc., or boilers needing boiler shop repairs. These engines are put outside of the shop when stripped until the main details are sufficiently advanced towards completion as to justify the engine being placed upon the erecting shop pit but no spare boiler is immediately available

Repairs of general details to such engines are not proceeded with in other shops until notice is given, which must be at least three weeks before engine is scheduled out.

The foreman stripper's report having been received in the office on the sixth day, with the order cards which have been made out showing all requirements in the way of new or repaired articles, and also the report from special examiners as to condition of motion, valves and faces, cylinders for renewal or boring, axleboxes, frames, etc., the actual ordering of the material upon the shop concerned is proceeded with.

These printed order cards are made out to the following benches, viz., piston bench, engine repair detail bench, motion bench, brasswork bench, cylinder bench, pick-up and spring bench. Copies are then made on tear-off pads, in triplicate, one set of which, with a copy of the engine house waybill, is sent to the gang foreman upon whose pit the engine is to be repaired; the second set is sent to the material progressman (a description of whose duties is given later), while the third set is sent to the department concerned with the repair or supply of the detail required.

The original order cards are forwarded to the finished



Muir Puncher Slotter Slotting Main Rods

work stores in the erecting shop. There each detail which can be supplied from the stock in hand is marked off.

The cards are then forwarded to the holders of the third copy, and the finished work storekeepers' mark indicates to all concerned that such details will not be paid for.

Upon receipt of these cards shop orders are issued to the various gang foremen in the repair department, and as the work is completed the gang foreman enters opposite the article the date of supply; no work can be paid for other than this.

The cards are made to serve as a very useful check upon arrears in the details of any particular engine. Each gang foreman is provided with a box in which he keeps all his cards in three batches, each batch in numerical order; the front group represents material due out from his department in the next fortnight, the second group due out in three weeks, and the third due out in four weeks.

All detail work is expected out of the repair shops at least seven days before the engine is due out of the erecting shops; should, from any cause, an item be still unsupplied on the seventh day prior to the output date of engine, the card is taken out of the box and hung upon a special board provided, which is headed, "Work not supplied for engines due out in 7 days or less." The arrears are thus kept prominently before both the progressman and the foreman, and this has a tendency to keep arrears to a minimum.

In every department in the shops an output board, forecasting the output for the next four weeks, is posted, and this board has the engine numbers rearranged weekly as a result of conferences held in the chief inspector's department with the foremen concerned.

It is easy for the gang foreman, after each weekly alteration, to rearrange his cards accordingly.

In the event of any unforeseen development during the erection of an engine, such as the breaking of castings, or

Engine Stripping Examination and Order Progress Card

Engine No..... Class of repair.....

Chief Inspector or Principal Foreman to initial and certify when work was completed.

Operation	Date to be filled in by inspector or stripper	Number of days to complete after first day on stripping pit	Chief inspector or principal foreman. Initial	Date
In works.....				
On stripping pit.....				
Tubes examined				
Tubes dealt with.....				
Boiler examined				
Class of repair, A, B, and C...				
Wheels examined				
Motion examined.....				
Axleboxes examined.....				
Cylinders examined.....				
Springs examined.....				
Material delivered to shop....				
Material ordered.....				
On boiler pit.....				
On erector's pit.....				
Put outside, if a "C".....				
Promise of material.....				
Out of shop.....				
Wired away				

Fig. 1—Inspection and Progress Card

items having been overlooked on the stripping pit, application must be made to the material progressman, who issues a supplementary order card.

This card is of a different color than the ordinary card and has a column in which must be stated the reason for such late order, thus checking any laxity of supervision, reckless handling of material, or carelessness in delivery of repaired details.

Boiler Pit

In the case of an *A* class repair which has been placed on a special pit set aside for boiler repairs, all loose rivets in frames, platforms and splashers are renewed, and bunker sides and bottoms repaired; this work is expected to be completed in 12 days, when the engine is transferred to the erecting shop.

A *B* repair class is dealt with in the same way except that the boiler is in some cases lifted and repaired at the end of the boiler pit while the frames, bunkers, etc., are receiving attention.

If the boiler needs such heavy repairs as tubeplate renewals or ½-side patches, then it is sent to the boiler shop and one of a similar type is pressed forward on the boiler mounting pit so that it may be tubed and tested in time for its delivery to coincide with arrival of frames in the erecting shop.

Where possible, with engines needing *C* class repairs, the frames, etc., are repaired on the boiler pit before being sent outside in order to prevent delay in dealing with the engine when the frames are brought back into the shop.

The following table shows the time allowed to perform the different classes of repairs:

Pit	"A" Repair. Number of days allowed	"B" Repair. Number of days allowed	"C" Repair. Number of days allowed	
Stripping	6	6	6	
Boiler	12	14	14	Note.—"C" type only brought into shops again when work is ready.
Erecting	12	14	18	
Total days in shops..	30	34	38	

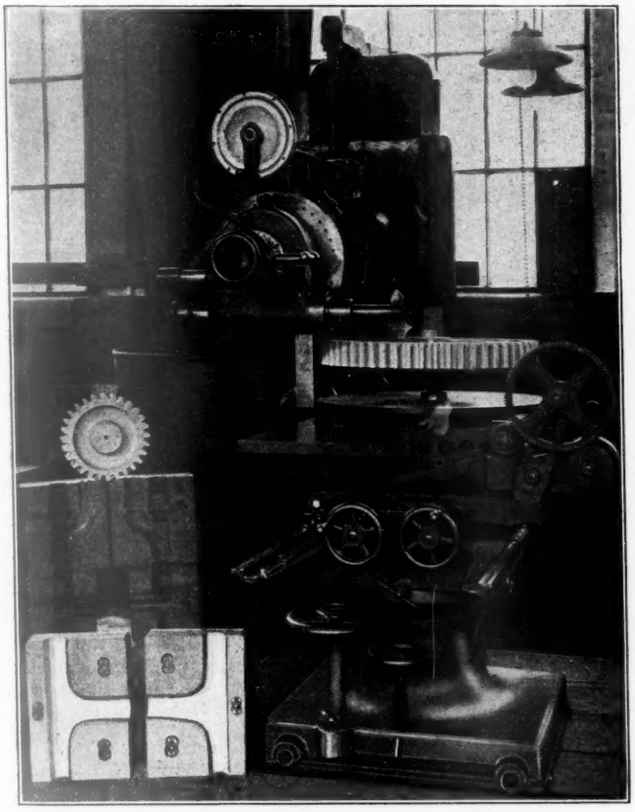
Progress Card

As a final summary of the system of engine stripping, examination and order progression a card system is used, the card being shown in Fig. 1.

These summary cards, described below, when completed, are returned to the chief inspector's office, and a monthly return of the average times taken for the various processes is shown.

Any card not completed within 10 working days of the date the engine goes on the stripping pit is sent to works manager's office for inspection.

The cards will be issued by the shop inspector, and when



Universal Pattern Making Machine Working On a Spur Gear Pattern

filled up, returned to his office so that the information may be summarized.

In actual practice the summary for two separate months' working came out as follows:

	April	May
Engines sent away which have cards	59	66
Average days on stripping pit	6.19	6.46
Average days on boiler pit	7.85	6.65
Average days on erector's pit	27.96	26.06
Total time in shop	38.98	37.57
Finished off outside	7.33	6.95
Average days, tubes examined	3.33	3.92
Average days, tubes finished off	7.71	8.9
Average days, boiler examined	2.87	3.01
Average days, wheels examined	4.89	5.00
Average days, motion examined	3.97	4.52
Average days, axleboxes examined	6.09	8.12
Average days, cylinders examined	5.3	6.26
Material delivered to fitting shop	7.5	7.83
Material ordered from erecting shop	7.43	7.49

Duties of Erecting Shop Progressman and Progressing of Material

The delivery of material requiring repairs to the other shops is under the supervision of an erecting shop progressman, who is responsible for seeing that all engine details are stewed or cleaned and delivered to the other shops within 10 days from the receipt of the engine upon the stripping pit.

He is also responsible for the delivery of all repaired details to the erecting pit to schedule, having regard to the position of the engine on the output board.

By a daily perusal of the output board and the duplicated set of ordered material lists he is able to keep his finger on the pulse of the erecting shop, and to anticipate them as much as possible so as to keep items from figuring upon the arrears list (issued daily).

The arrears list, which is compiled by the progressman, contains all items not supplied to engines due out in the next seven days, and a copy is placed before each foreman at the daily conference, and later in the day is put before the manager together with the remarks made at the conference by the foremen concerned.

Twice daily, at specified hours, the progressman is interviewed by gang foremen who want such items as frame stays, pedestal blocks, etc., at an earlier date than the ordinary details; also by others who have material verging upon the arrears date and not yet to hand.

Finished Work Stores

In connection with the locomotive repair organization is a finished work store combined with a central order department.

The function of this store is to provide a daily and yearly record of new and repaired articles supplied to the erecting shop and the outdoor locomotive department. At the same time it insures that a maximum stock is not exceeded or a minimum stock depleted. At any time the stock of any item may be ascertained by the card index system in the store. By this means a system of central ordering is possible—which in its turn permits of articles being ordered in considerable quantities with consequent economy in production. It also provides a perfect and complete check on payment for machining and insures a ready supply for the erectors of the outdoor locomotive department of each article required.

Erecting Pits

The erecting shop crews consist of a gang foreman, five journeymen fitters, three apprentices, one hand driller, who acts also as laborer when not occupied with drilling. An additional laborer divides his time between two pits, sharing in any two-handed job as required, such as pinching or racking engine when valve-setting, replacing grate bars, etc.

Upon receipt of an engine, or frames from the boiler pit, the laborers at once scrape and clean the frames and pedestal blocks; the work of renewing loose pedestal and cylinder bolts is then commenced; where necessary the holes are opened out by drillers with portable electrically driven drills; fractured frames are chipped out to a feather edge and are afterwards oxy-acetylene or electrically welded, all studs upon cylinders and boiler (in the case of an *A* repair) are sounded and doubtful ones renewed, broken ones being drilled out.

Inequalities are removed from pedestal jaw cheeks, and the axleboxes (which, along with the brakework, etc., have been to the stewpot and are now delivered to the pit by the stripping pit gang) are tried up in the pedestal, adjusted and marked off for boring.

If a *B* class repair the boiler will now be to hand, and is at once placed in the frames and fastened down.

While the lagging nailing strips are being fitted on by a floating gang the erecting gang are, in the case of a changed boiler, setting the handrail brackets, jointing the steam tee-pipe and steam pipes, fitting the ashpan and grate bar brackets.

When this work is completed another floating gang of laborers place the asbestos mattressing in position. The sheathing is then applied, the cab is temporarily bolted, as is the smokebox, and the riveters take these in hand.

Meanwhile the guide bars are set and the motion work with the reversing gear are fitted by one fitter and apprentice, while another pair will have taken the wheels in hand and be

mounting the axleboxes, hanging springs, etc., in readiness for wheeling; a fitter will also be engaged during the operations in placing all pipes, in the cab and below, in position.

After wheeling, the engine is placed upon a cradle and the valves are set by micrometer in accordance to figures supplied from the inspection department.

These figures are issued on duplicate slips, and based on vernier measurements taken of ports and valves.

Running Trial

This takes the form of about four hours' working of branch passenger traffic. Before trial the brake is tested by the brake inspector, who is responsible for the vacuum brakes and examination of all accessories.

The inspector keeps and maintains records of the life of all diaphragms and brake parts, and reports monthly upon their life.

It is possible to run four engines per day in this manner, but an average of about three per day is maintained, not including Saturdays. Saddle tank and dock engines, along with steam rail motors, however, are run in the shop yard and do not require to go on the branch line.

In all cases, at the conclusion of the run, the driver makes a report on the behavior of the engines, triplicate copies are then issued, one to the trial inspector, one to the foreman of the erecting department, and the third is sent to the gang foreman, under whose supervision the engine was repaired.

As soon as the engine is ready to go out, it is carefully examined by the trial inspector for possible defects or omitted repairs; the trial inspector takes the engine for a short run in the shop yard, after which, should everything be found correct, the engine is wired into traffic, unless it requires painting. The engine then goes to the weighbridge to have the weights adjusted and during this adjustment the trial driver's report enables the gang foreman to rectify any minor defects that may have revealed themselves on trial. The outdoor locomotive department are informed that the engine is ready for traffic unless it requires repainting.

Paint Shop

Engines are usually a month in the paint shop as all the old paint upon splashers, cab and sides, tanks and bunkers, needs removing with some detergent before repainting.

The covering will, in the majority of cases, have been sent to the stewpans while the engine was on the boiler or erecting pits and therefore is not in need of any further preparation.

Return Into Traffic

As soon as a repaired engine is wired into traffic the waybill is forwarded through the outdoor locomotive department to the district locomotive superintendent of the district to which it is allocated.

The waybill at this stage has upon it the whole of the repairs stated in detail, the condition of firebox sides, thickness of valves, etc., etc., and is accompanied by up-to-date stay and tube charts.

After the engine has been in traffic for six days the district locomotive superintendent fills in on the waybill repairs or adjustments which have been necessary during that period. The waybill is then returned to the shops and the defects are brought to the notice of the foremen for explanation.

Closing Triple Valve Piston Ring Grooves

An efficient device for slightly closing the packing ring grooves in triple valve main pistons is illustrated in Fig. 1 and shown in detail in Fig. 2. The principle of the device is simple, since it consists of delivering a heavy blow on the curved portion of the piston head by means of an air hammer, thus closing the ring groove not only at the outer portion, but the whole depth. This method is used to reclaim pistons with badly worn grooves and thus reduce the number of new ones to be bought.

The device consists of a steel shell turned and bored out to form an air cylinder as indicated. A removable anvil, *A* (Fig. 2) is supported on block *B*, which is drilled and slotted to receive the triple valve piston. Plunger *P* is normally held in its upper position by means of a coil spring and is operated by the piston shown. A packing leather with the customary expanding ring is used to make this piston tight in the cylinder. On opening the operating valve it is evident that a rush of air on top of the piston will cause its downward movement against the compression of the spring and will deliver a heavy blow at the desired point of the triple valve piston.

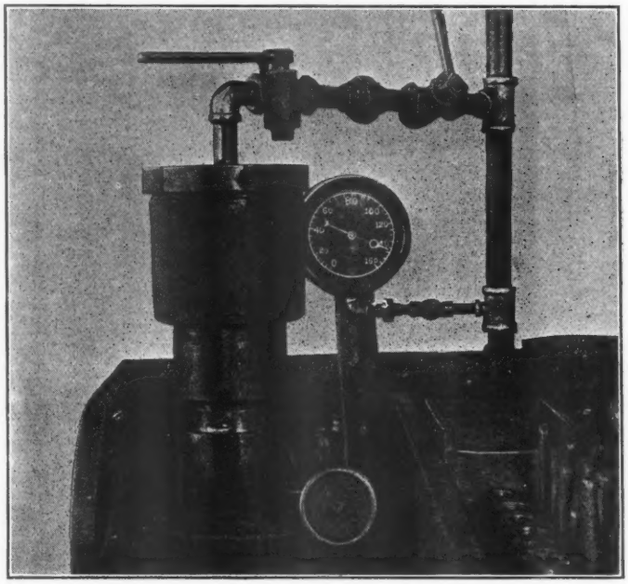


Fig. 1—Device for Slightly Closing Triple Valve Piston Packing Ring Grooves

The triple valve piston is absolutely centered on the anvil block by the holder and is sufficiently closed by one blow with 75 to 90 lb. air pressure per sq. in. After closing the grooves, the pistons are chucked in a small lathe and the grooves machined to the standard width, using a special tool holder. Standard cutting off tool blanks are used in this holder so that the only grinding required is on the end. Piston rings are fitted to the grooves after machining by lapping on fine emery cloth until they will just enter the groove under hand pressure.

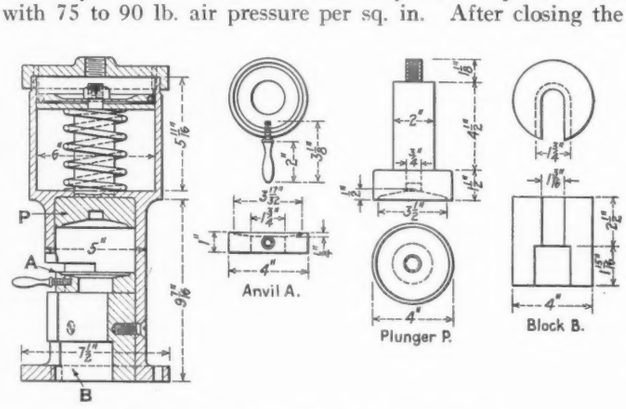


Fig. 2—Details of Groove Closing Device

A Short Cut in Squaring Locomotive Valves

Valves Are Squared by This Method Without Applying the Main Rods and Afterwards Removing Them

BY WILLIAM ULRICK
Foreman Valve Setter, Scranton Shops, Delaware, Lackawanna & Western

At the present time when it is necessary to obtain maximum production in all locomotive repair shops, the following method of squaring either Baker or Walschaert valve gears without applying the main rods will be found a great time and labor saver. The process has been used for several months with good success, only an occasional readjustment of the valves being necessary, which is likely to happen with any method of valve setting.

In practically all railroad shops the practice is to apply main rods before setting the valves and afterwards it is necessary to remove them before applying the side rods. This is an unnecessary repetition of work and can be avoided by the following method. The first operation before setting either of the valve gears referred to is to apply the various parts of the motion work and see that all are in good working order without lost motion or undue friction.

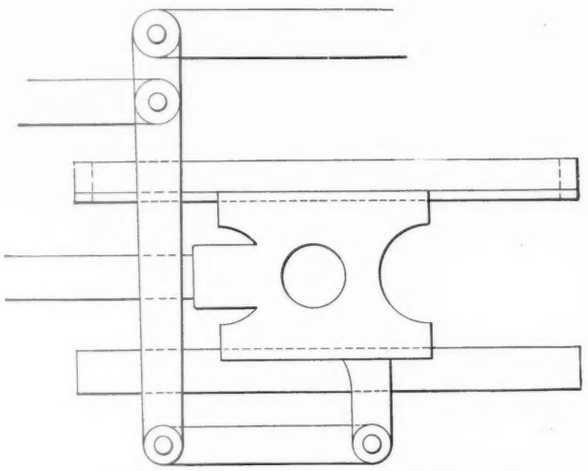


Fig. 1—Positions of Parts With Crosshead and Radius Bar on Center

Method of Procedure

After all parts of the motion work are in place, the port marks are taken as usual, using a tram to transcribe the marks to the valve stem. Dead center positions of the crank pin are scribed on the wheel center (right or left as the case may be), using the customary tram. Since the main rods are not up, a special light fish-tail tram has been devised to take their place simply while getting the dead centers. This tram consists of a brass plate cut in the form of a fish tail and bearing on the crank pin at two points. Attached to the brass plate is a light 1 in. by 4 in. wooden strip approximately equal to the main rod in length and having an adjustable scriber at the end. With the crank pin a little above the dead center a vertical line is scribed on the cross-head at a level with the wrist pin hole. The wheels are then rolled past the center until the scribing point on the tram comes back to the original mark. The two positions are marked on the wheel center in the usual manner and dividing the distance between them gives one dead center. The other dead center is obtained in a similar manner.

The main crosshead is now placed in the center of the stroke, determined from the travel marks, with the reverse lever also on center as shown in Fig. 1. If all motion work parts are the right length, properly adjusted, and the link block is at the link center, the center line of the combination lever will be vertical. If the combination lever does not stand vertical, it is due to a defect or combination of defects which will be explained later together with the remedies.

To check the position of the eccentric arm, the wheels are turned, catching either the front or back dead center and with one end of a tram at the center of the link foot, a line is scribed on the guide yoke or any other convenient stationary place. Then the other dead center is caught and the same tram used to scribe a similar line. If the two lines come in the same place, it is evident that the eccentric crank arm is properly located. If, however, the two lines come, for example, ½ in. apart, the eccentric crank arm is shifted on the main crank pin so that the tram mark will come halfway between the two lines. This setting will give the correct location of the eccentric crank arm but if trial shows that a slight error still exists, it will necessitate going through the operation twice.

The reverse lever is now thrown in full gear forward and the nearest center caught, rolling the wheels forward. The position of the valve is scribed on the valve stem, using the tram previously employed to scribe the port marks. The wheels are then rolled and the travel of the valve marked on the valve stem. With the reverse lever thrown to the full gear backward motion, the centers and travel marks are again obtained in the same way.

If the valves are properly set, all marks on the valve stem that were scribed by catching the dead centers, will come in the center of the port marks, because the lap and lead lever is stationary and the valve is not receiving any motion from the cross head. In other words, the effect of the lap and lead lever is eliminated.

The valve travel, as obtained by this method, is for all practical purposes correct since the extreme travel takes place when the engine is very nearly on the top or bottom quarter. This would bring the cross head practically to the center of the stroke, even if the main rod was applied. Port and travel marks when the valves are properly squared are shown in Fig. 2, although it is not necessary to have an equal amount of port opening, front and back, as long as there is the same amount of travel on both sides of the engine. For example, if the right side has 6 in. travel, the left side should also have 6 in. travel, which is obtained by shortening or lengthening the radius bar lifter or short reach rods, as in the ordinary method of valve setting. Fig. 2 is of rare occurrence in the Walschaert gear, as it is impossible in

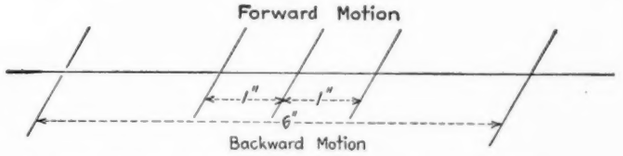


Fig. 2—Port and Travel Marks When Valves Are Square

some gears to get a square valve and the same amount of port opening on each end in full gear. In the Baker gear, it is a bad error as the maximum port opening nearly always will vary from ½ in. to ⅝ in., which cannot be overcome as the gear is at present designed.

Defects and Their Remedies

The positions of tram marks secured when the eccentric rod is ⅛ in. too short are shown in Fig. 3. It is evident that the valve must be moved ahead or to the left ⅛ in. in the forward and back ⅛ in. in the backward motion in order to make the valve square. As indicated in Fig. 3, due to the position of the radius rod, a change of ½ in. in the length of the eccentric rod would produce a movement of the valve of only ⅛ in., due to the ratio of 4 to 1. On account of the forward motion being direct and the backward motion indirect, the eccentric rod must be lengthened ½ in., which will bring both tram marks to the center.

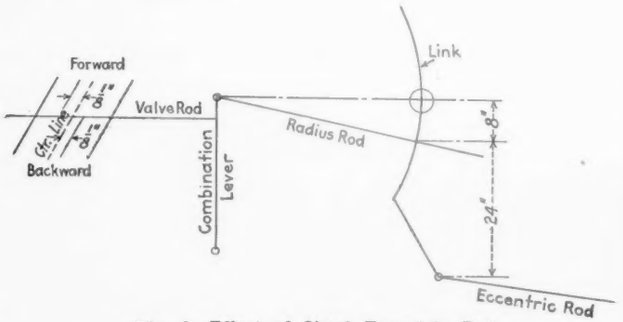


Fig. 3—Effect of Short Eccentric Rod

The positions of tram marks with a radius bar or valve rod ⅛ in. too long are shown at *A*, Fig. 4. It is evident that shortening the radius bar or valve rod ⅛ in. will correct this condition, but the question is, which shall be shortened? The radius bar should be maintained as nearly as possible the same length as the radius of the link, a condition which is easily checked as follows. With the link on center and a radius bar of the correct length, the reverse lever can be changed from full forward to full reverse gear without moving the valve. Alterations in the radius bar are made until this condition holds true. In the above problem, if the radius bar is checked and found to be the correct length, it is obvious that the valve rod must be shortened ⅛ in. or the valve adjusted on the rod, which amounts to the same thing.

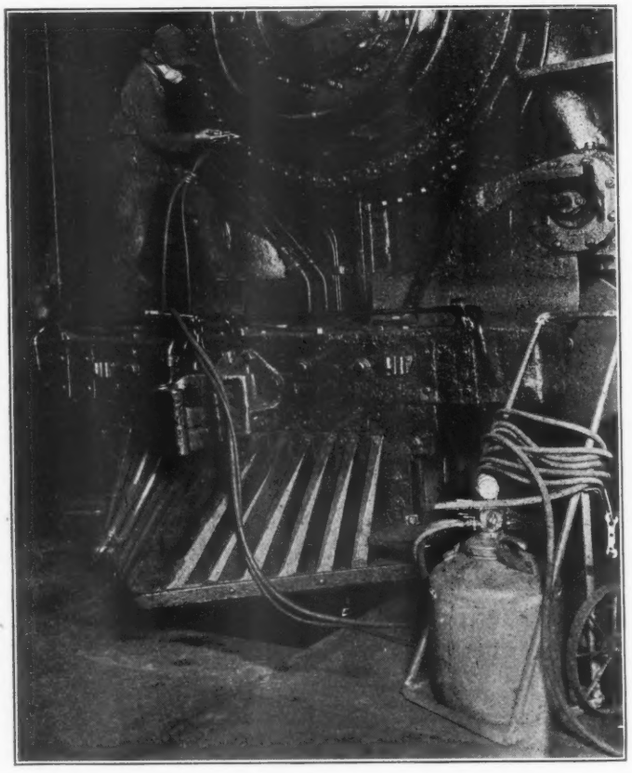
Fig. 4—Effects of Long Radius or Valve Rod and Short Eccentric Rod

The effect of a long valve rod and short eccentric rod are shown at *B*, Fig. 4. Shortening the radius bar or valve rod ⅛ in., will give the condition shown in Fig. 3, which can be corrected by lengthening the eccentric rod ½ in. When the front and back motion marks are all taken, it is advisable to throw the reverse lever nearly to the central position and turn the wheels one complete revolution, taking the complete travel marks. These will come equal distances either side of the port marks, according to the position of the reverse lever. If the lever is hooked up shorter, the distance will be larger; if thrown toward the corner, it will be less. If this is done in the forward motion or with the lever hooked up in the running position, any slight error due to lost motion or irregularity in the valve gear (especially in the Baker gear) will be overcome. If these measurements are not equal a slight adjustment on the valve, by shortening or lengthening, will overcome this error. The method of squaring valves described is not capable of the refinement of some other methods and does not give all of the events of the stroke. On the other hand, it reduces the time required for squaring valves by about three hours and saves the cost of labor for applying and removing the main rods. Several months' actual use of this method has failed to show that greater refinement was necessary.

Paint Spraying Locomotive Front Ends

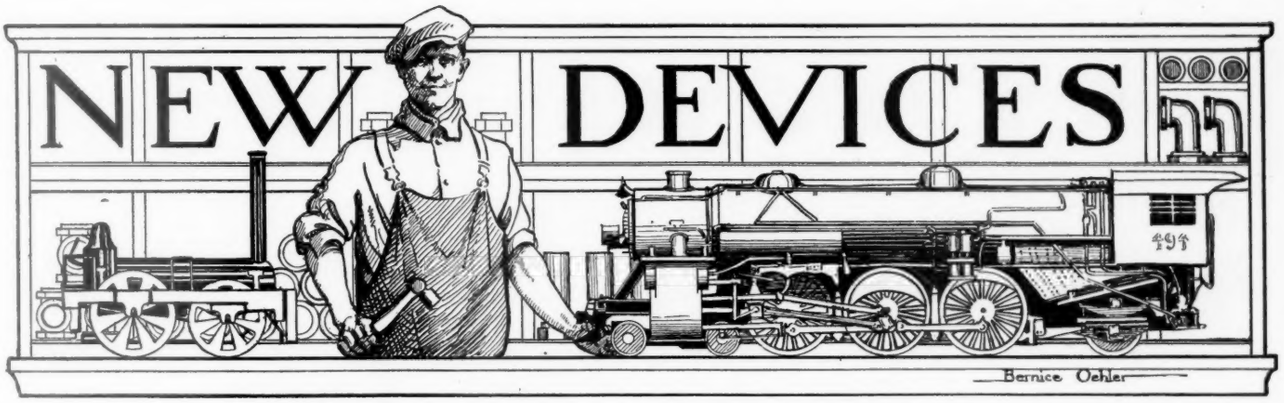
The proper maintenance of equipment requires frequent painting of locomotive front ends and this work consumes a large amount of time where it is done with a brush. To decrease the time required for the operation and permit keeping front ends in good condition, various forms of paint spraying equipment can be used to good avantage.

For greater convenience in moving about, the paint spraying equipment illustrated has been mounted on a two-wheel truck and can be moved readily from place to place by one man. Arriving at the engine to be painted, it is only a question of coupling the air hose, adjusting the respirator and starting to work. The job is finished in a short time and the outfit moved on to the next engine.



Easily Handled Paint Spraying Equipment

Trouble is Sometimes experienced by the lead sticking to the work. This can be avoided by dipping the article in a solution of cyanide of potassium and water—about one pound of powdered cyanide to one gallon of boiling water. This should be used cold and the article permitted to dry before placing in the lead bath. The pieces should be left in the lead only long enough to heat them through. The pieces can be quenched in oil, water or brine, as preferred.—From Houghton's "Steel and its Treatment."



Single Pedestal Swivel Type Car Seat

A CAR seat involving several important changes from the usual type of construction has been invented and patented recently by Frank Smolar, Dayton, Ohio, and will be placed on the market by the Dayton Car Seat & Manufacturing Company of the same city. One of the principal objects of the new invention is to provide a car seat with a minimum weight consistent with strength and rigidity. The seat may be automatically locked when in either extreme position and is stated to reverse easily, no lubrication being required. The swiveling feature makes it necessary to provide only one foot rest.

Fig. 1—Normal and Inclined Positions of Smolar Car Seat

back not normally inclined. The occupant inclines the back at will against springs in the arm rests to whatever position may be most comfortable and the springs return the back to its normal upright position when the seat is vacated. The inclined position of the back is indicated plainly by dotted lines in Fig. 1.

The new car seat is light in weight, easy to install, and is not connected to the wainscoting. The latter feature eliminates drilling and tapping the wainscoting, and using the window sill as an arm rest. The seat may be easily and quickly assembled and dismembered for cleaning purposes without the use of tools. A greater height than usual is available for steam pipes and there is ample room for suit cases and traveling bags under the seat bottom. An especial effort has been made to secure simplicity of construction without complicated parts to break or get out of order; also a

A view of the Smolar car seat, disassembled, is shown in Fig. 2. *A* and *B* are the seat and back cushions respectively. The main seat support consists of a steel casting or pressed steel frame work supported upon and guided by the frusto-conical pedestal *D*. Each arm rest *E* is divided horizontally, the lower section having a deep longitudinal recess, containing the anchor piece, spring, slide piece *G* and guide. Tension of both arm rest springs through the connections shown holds the back cushion in its normal upright position. The top section *F* is provided to cover the recess and parts enclosed in the arm rest.

The foot rest *H* is secured by means of two hinges to the main seat frame. A dog is provided which engages the slot

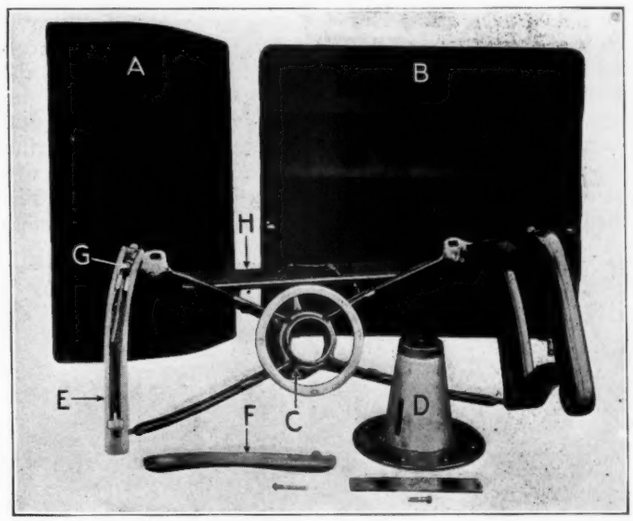


Fig. 2—View of Car Seat Parts Disassembled

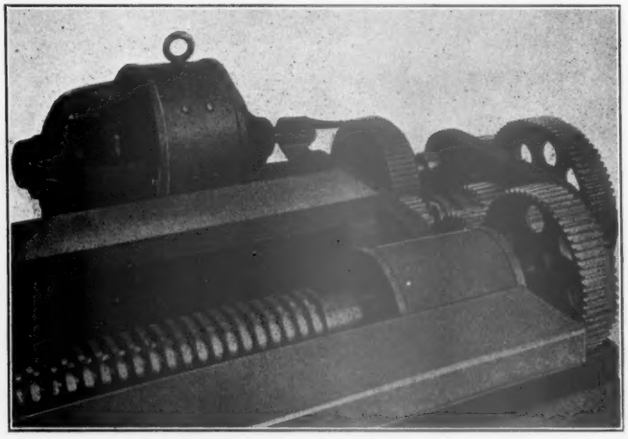
in the pedestal and holds the seat firmly in either of its extreme positions. A small spring holds the dog in engagement with the slot and foot pressure on a small pedal casting fastened to the foot rest releases the dog and allows the seat to be swiveled.

Owing to the fact that the back does not need to be pulled over, cushions for the new car seat can be made to practically any desired height, width or shape to provide the greatest comfort for the passengers.

Heavy Duty Motor Driven Face Grinder

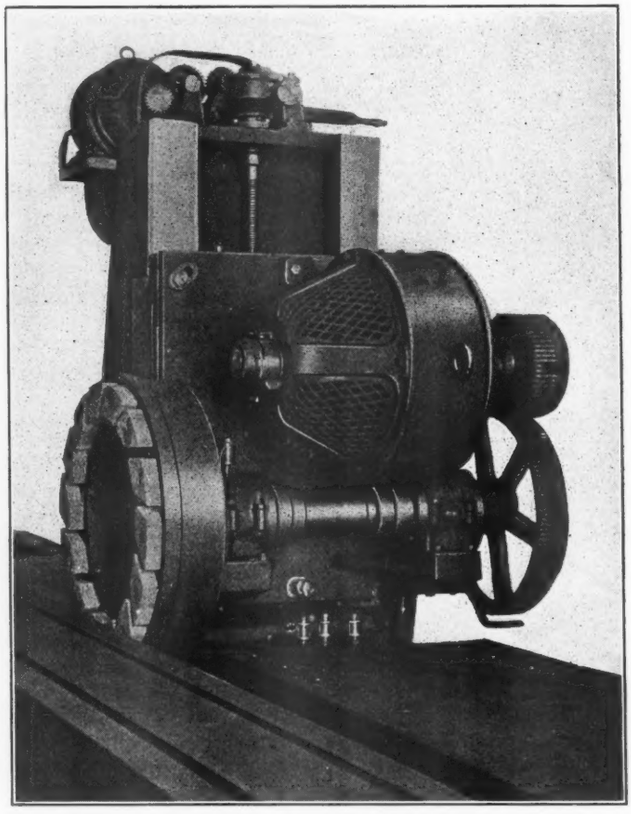
A MOTOR DRIVEN face grinding machine intended for heavy duty has been developed recently by the Bridgeport Safety Emery Wheel Company, Bridgeport, Conn. The new machine is arranged to be driven by an alternating current or direct current, 40-hp. motor, operating at a speed of 1150 r. p. m. For driving the lead screw and traveling head, a 7½-hp. motor running at the same speed is used. The grinding wheel is raised or lowered by a smaller 3½-hp. motor running at 850 r. p. m.

The machine, designed to be set on mason work which forms a solid foundation, has a bed 30 ft. long for grinding work 24 ft. long. The bed has flat top rails, 6 in. wide, over which a short carriage is traversed, gibbed to take up for wear, with a heavy column securely mounted. The column has one upright face finished with wide, flat tracks and a gibbed carriage with a 2-in. elevating screw for vertical movement of the grinding wheel. On this carriage there are horizontal tracks with a carriage for feeding the wheel up to the work. Movement of the carriage is by means of a 1½-in. screw and a 14 in. hand wheel. On top of the horizontal carriage there is a turret pivoted at the center so as to grind the work square across or at an angle, with a clamping screw at each corner to hold the turret firmly where placed. The motor and grinding wheel spindle are bolted to the turret so that both move together when swiveled. The machine has a wide-faced fibre pinion meshing into a gear about twice its diameter on the back end of the grinding wheel spindle. This provides a back gear arrangement of about 2 to 1.

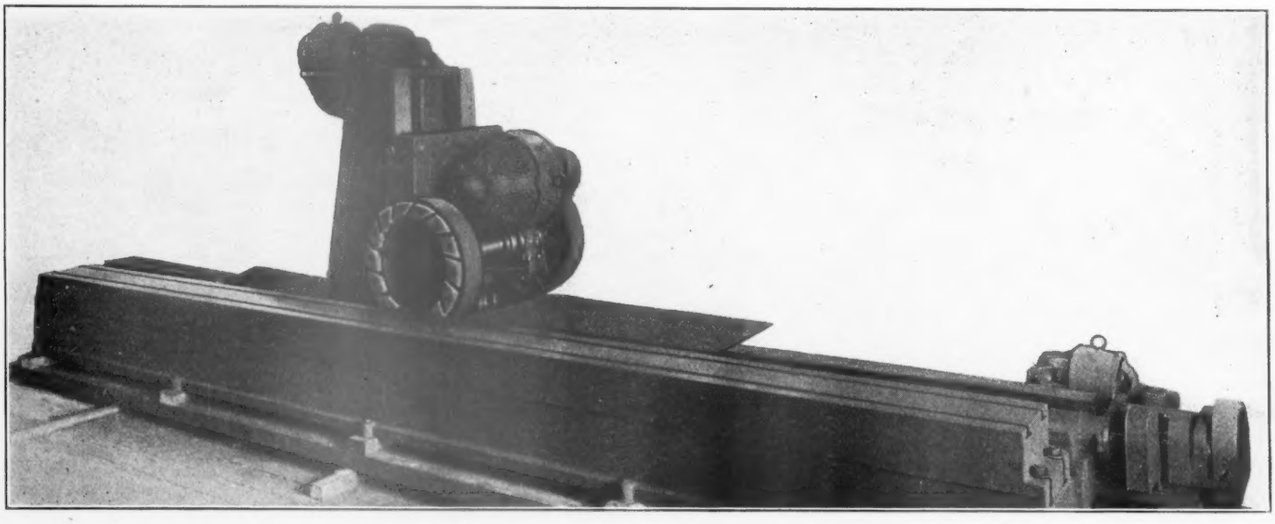


Mechanism Operating Lead Screw

The wheel spindle runs in ball bearings with end thrust ball bearings each way, adjustable endwise for any wear. It is stated that machines have been run constantly for eight years on hard work, with bearings thus constructed, and have given the best of satisfaction. The grinding wheel is made up of 14 sectional blocks forming a wheel 32 in. in diameter, 8 in.



Wheel Drive and Elevating Mechanism



Heavy Duty Face Grinder With Traversing Column and Grinding Wheel

deep, with a cutting rim 4 in. thick. An open space is provided between each section for material ground off to work into, as is common with metal-working tools. The motor on top of the upright column, designed to operate the grinding wheel head up or down through spur and worm gears, is back-geared down to a practical speed for the elevating screw. A shifting lever operates the gears to move the wheel head up or down as desired.

A suitable cast iron guard covers the gears on the motor and grinding wheel spindle. There is a 5 in. lead screw through the center of the entire length of the bed, connected at the left hand end to the 7½-hp., motor through a chain drive and a train of spur gears to get the right reduction of speed between the screw and the motor. There is in this train a toothed clutch operated by the shifting lever to revolve the lead screw in either direction to make an automatic traverse of the wheel. The lead screw runs in radial ball bearings at both ends and also has end thrust ball bearings on each side of the box at the right hand end of the lead screw, with adjustments for any slight wear. There are several supports under the lead screw, between the end bearings, to prevent the screw from sagging.

On the front of the column at the bottom is a stop that comes in contact with the shipping dogs for automatically reversing the traverse of the column. These dogs are on a shipping bar extending the full length of the bed, supported at about five points, and two shipping dogs between each bar support, pivoted so they can be thrown back quickly out of the way and only two of them used as required to cover the range of travel desired.

There is a work supporting bed the length of the machine, with a working face 18 in. wide, having two T slots the full length. The work is firmly bolted to this bed so the face to be ground comes in contact with the grinding wheel; if the work extends back from the table to any great extent, it should be supported by suitable horses. A full length supplementary table, 10 in. deep, is provided to go on the work table when small pieces or sheet stock is to be ground.

Tube Safe End With Square Shoulder

A NEW design of tube safe end, manufactured by the Coleman Boiler Appliance Company, Los Angeles, Cal., is provided with a square shoulder and a taper fit in the back tube sheet, the ends being beaded over as usual but not electric welded. The principal object of this new safe end is to hold the tube firmly against movement in either direction and eliminate leaks in the firebox, thus increasing the tube mileage and reducing engine failures due to leaky tubes. It is stated that the Coleman safe end is particularly effective in bad water districts and can be used successfully on oil burning locomotives. It has been tested over a period of 30 months on the Atchison, Topeka & Santa Fe with satisfactory results and is now being introduced on other prominent roads throughout the country.

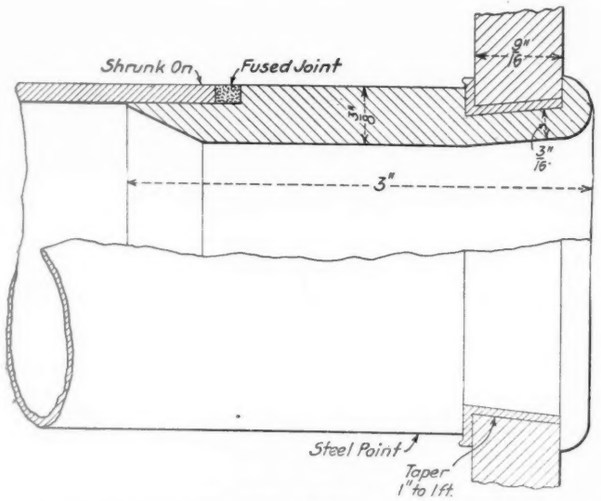


Fig. 1—Cross Section Showing Application of Coleman Safe End to Boiler Tube

The inherent objection to the common type of safe end, set by means of roller and Prosser expanders, is that the semi-circular corrugation on the water side of the tube sheet touches the copper ferrule at the edge only and cannot prevent more or less working of the tubes due to expansion and contraction. This working is bound to cause leaky tubes even when they are electrically welded and the results are serious and costly engine delays on the road and at terminals.

To overcome the above structural weakness, the Coleman tube safe end has a square shoulder, as shown in Fig. 1, which is pressed solidly against the copper ferrule and tube sheet. The tube sheet hole is slightly tapered (2¼ in. to the ft.) and the tube end is beaded over as usual. It will be obvious that the square shoulder prevents movement of the tube toward the firebox. The beaded end, in conjunction with the taper bearing, holds the tube against forward movement and this construction, by preventing any movement of the safe end in the tube sheet, eliminates leaks from this cause.

A comparison of the Coleman and the Prosser expander methods is shown in Fig. 2 and attention is called to the smaller tube sheet holes required. This results in wider bridges and therefore increases the strength of the tube sheet which will offer a greater resistance to stretching when the tubes are worked. Tools used for applying the Coleman safe end are the same as for the standard safe end, except that the Prosser expander is eliminated and a sectional expander with the correct taper substituted. A roller expander arranged to give the proper taper of 2¼ in. to the foot is used only on the initial installation of the tubes.

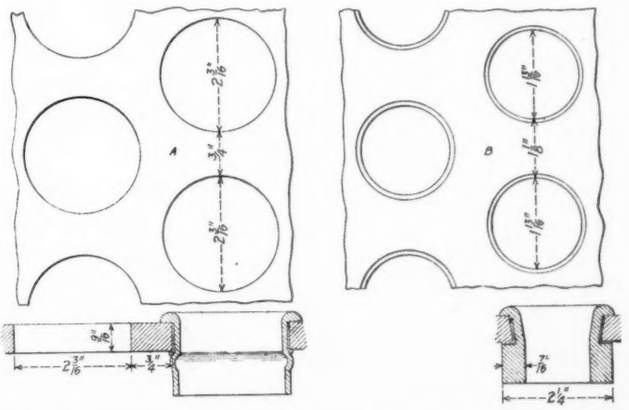


Fig. 2—Comparison of Prosser Expander and Coleman Methods

Elimination of the Prosser expander is an important advantage. After the old style tubes have been prossered two or three times, the tubes will be damaged by any further use of this tool unless exceptional care is taken. The use of a sectional expander without the Prosser, however, does not distort and weaken the tube nor cause it to crack on the

water side of the sheet, as is often the case with the old style tube which requires frequent working to keep it tight. It is stated that owing to its structural design, the Coleman tube safe end requires about 10 per cent less working than the straight safe end which has been prossered.

In applying the new safe end to an old tube, the tube is shrunk on, as shown in Fig. 3, leaving a small space to be filled in and form the fused or welded joint. Either the electric or oxy-acetylene process may be used in making the weld, which is said to cost less than the ordinary lap weld

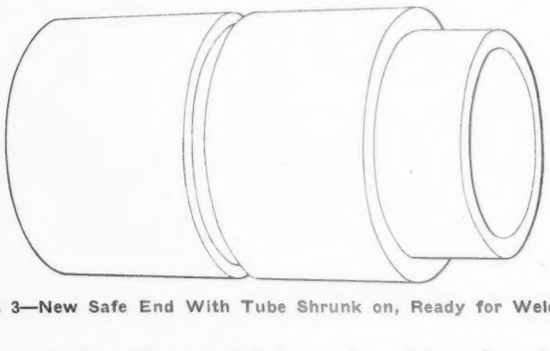


Fig. 3—New Safe End With Tube Shrunk on, Ready for Welding

and to be less likely to fail in service. The value of the Coleman safe end as a safety device is based on this claim.

Many tubes start to work in the tube sheet and leak soon after being applied because of sagging, especially when very long. Moreover, some tubes sag more than others, thus causing an uneven contraction and expansion. In order to prevent the above conditions, which are bound to result in leaks, a simple, inexpensive tube support has been designed as shown in Fig. 4. The first row of tubes is supported at the center on one continuous strip of iron properly bent and set on the bottom of the boiler. Above this row, individual supports of the form illustrated are used. Fig. 4 also shows a perspective view of the copper ferrule used with the new safe end.

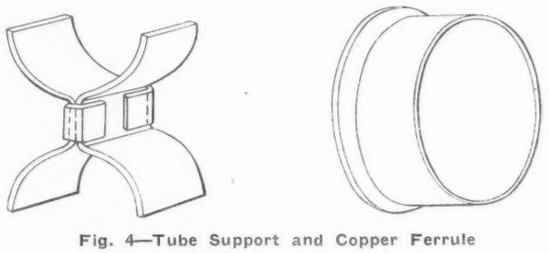


Fig. 4—Tube Support and Copper Ferrule

Careful tests indicate that the use of Coleman safe ends greatly increases the life of tubes over that obtainable with former methods of safe ending. In addition, leaky tubes are practically eliminated, thus reducing engine failures and delays on the road and at terminals. As a further important advantage, it is maintained that the decreased size of tube ends at the firebox tends to cause more complete combustion and make a better steaming locomotive; also one which burns less coal to develop the same tractive effort.

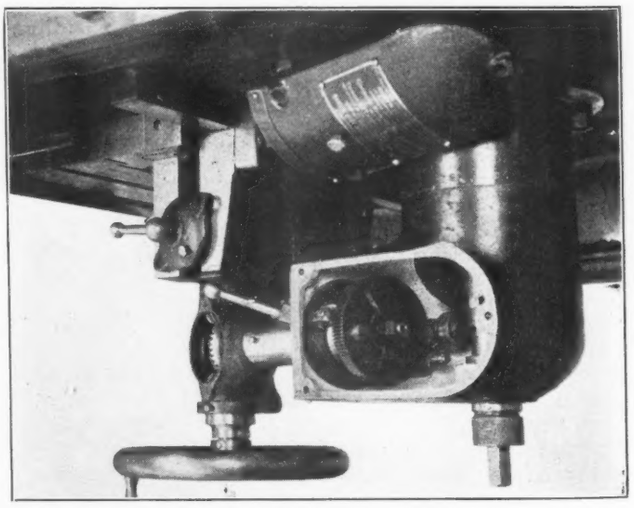
Two-Unit Feeding Device for Shapers

SIMPLICITY and sturdiness are features of the new feed for shapers introduced by the Queen City Machine Tool Company, Cincinnati, Ohio. The device consists of two units, the one at the bull wheel bearing regulating the amount, and that at the rail screw, the direction in which the table will be moved. At the end of the long bull wheel hub, a large face cam is mounted, revolving with an easy undulating motion and immersed in oil. The action of this cam through the large roller to the ratchet pawl is in a straight line, without links or intermediate parts, causing very little strain to the swinging arm that carries the roller.

The ratchet wheel is unusually large and drives the splined sleeve of the feed shaft through the medium of a safety friction. This is a great advantage, when it is considered how easily the table can be run to the limit of its traverse, or a wrench accidentally dropped where it will interfere with its working. If adjustments are necessary they can be made as easily as clamping the tool and with the same wrench, but powerful spider springs provide a driving pressure ample for all needs and an automatic "take up" for wear.

The swinging arm, mentioned as carrying the roller and pawl, has a large bearing on the outside of a sleeve which is pressed into the housing, upon the inside of which the double splined feed shaft sleeve is fitted. The swinging arm is held toward the cam by a long torsion spring. The amount of feed is controlled by a stop on the adjusting handle extension inside, which acts to limit the swing of the roller arm, the spring being automatically varied to the tension required by the movement of the handle. The feed controlling lever can be placed in zero position, at which point no part undergoes wear, or is in motion, and the movement of the parts is always proportionate to and no greater than the amount of feed which is being used throughout the sixteen changes provided.

The reverse box lever indicates, by its position, the direction in which the table will move and starts and stops the feed. The box contains the familiar bevel gear and clutch construction, the clutch teeth being integral with the gears and strongly proportioned, and the mesh of the gears being adjustable for wear. The use of a partition back of the cam, and the liberal use of felt oil retaining rings and wipers, makes practical the use of splash lubrication. The journals are all ground and of large proportions. The roller, pawl, ratchets, etc., are hardened and ground and the cam is accurately ground on a special machine.



Queen City Shaper Two-Unit Feed

The sliding connection to the rail is rigidly supported by a long sleeve. The driving keys are long and the shaft, by its position, prevents any binding tendency. All moving parts are enclosed and dust proof. The convenience of con-

trol is obvious, the feed always taking place upon the back stroke of the ram without attention or adjustment.

A strict schedule of interchangeability is maintained with a complete equipment of jigs and gages. It is stated that in a severe 55-hour test at excessive speed against a brake no weakness developed in this new feed.

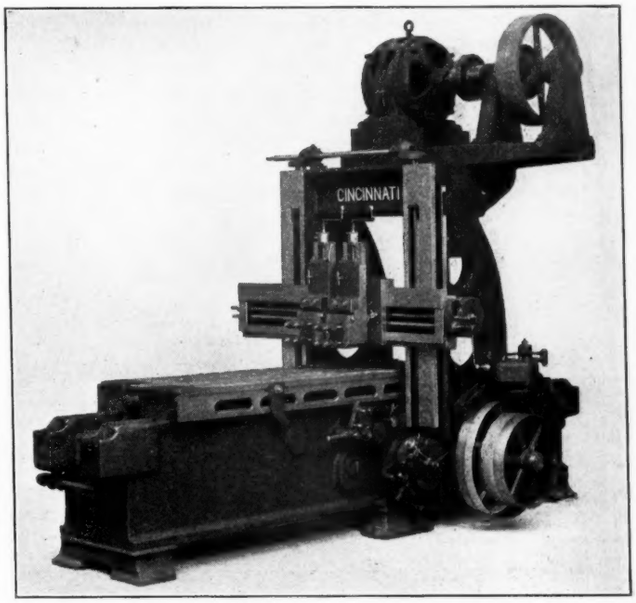
Thirty-Inch Shoe and Wedge Planer

RECENT improvements in planer construction have been incorporated in the 30-in. shoe and wedge planer illustrated. The new machine, which is made by the Cincinnati Planer Company, Cincinnati, Ohio, is designed for heavy service and the extra heavy box bed has a cast closed top over its entire length except where the bull wheel meshes into the rack.

Herringbone gears and all steel gearing in the bed provide for uniform power transmission to the table and little possibility of interrupted service due to gearing troubles. All gears are well oiled by means of a force feed lubrication system. A deep and strong box table reduces the possibilities of springing and getting out of shape to a minimum. For convenience when setting up work, the stop holes are drilled all the way through the upper half. This saves time usually required for cleaning out stop holes before inserting a stop. The lower half, which is cast solid, prevents the dust and chips from falling through and into the vees.

Each housing extends to the bottom of the bed and is fastened in correct alinement to the side of the bed by means of a tongue and groove, bolts and dowel pins. The faces of the housings are exceptionally wide to provide a proper bearing surface for the back of the rail. A heavy box arch, provided for tying the housings together at the top, affords increased strength and rigidity. As noted, the saddle has a wide bearing surface on the rail.

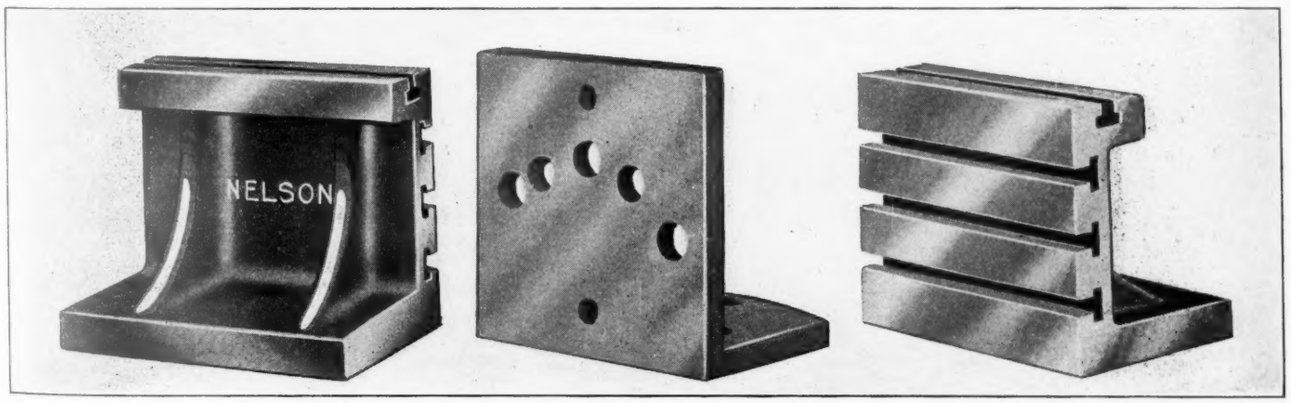
Both tool heads are mounted on one saddle, causing them to move crosswise in unison, but provision is made for moving them up and down independently by hand or by power. The widened bearing surfaces, in addition to the exceptional weight, strength and rigidity of all parts, assures a rigid cutting tool and a firm, smooth planing action. The new planer is regularly equipped with a two-speed counter shaft but can be conveniently arranged for plain or variable speed motor drive as shown in the illustration.



Cincinnati 30-In. Shoe and Wedge Planer

Angle Plate With Second Face and T-Slot

AN additional face and T-slot have been provided on a 90 deg. angle plate manufactured by the Nelson Tool & Machine Company, Newark, N. J., and placed on the market recently by the Fairbanks Company, New York. This angle plate is made of high grade iron machined accurately and true to master plates, all T-slots being formed by milling. By means of an additional T-slot in the second face, work can be strapped in either of two planes, whichever is more convenient for the rapid, accurate machining of the piece. Nelson angle plates are made in four standard siges: 3 in. by 3½ in., 6 in. by 9 in., 10 in. by 12-in. and 14 in. by 18 in.; larger sizes are made to order. They are adapted for use on shapers, planers, millers, drill presses and other machine tools in railroad shops.



Comparative Views of Nelson and Home Made Angle Plates

Advantages of the Nelson 90 deg. angle plate as compared to a home-made angle plate are indicated in the illustration

and include greater rigidity, greater ease of set up and adaptability to a greater variety of work due to the second holding face. It may be that the first cost of the home-made angle plate is low, but the final cost is high if account is taken of the time lost in setting up jobs with this type of angle plate which necessitates looking for special clamps and drilling holes for nearly every job.

With railroad shop machinists receiving 85 cents an hour for their time, it is evidently good economy and wise shop management to furnish an ample supply of jigs and fixtures which will facilitate machine operations and eliminate as far as possible time spent in setting up work. In many cases special jigs and fixtures can be manufactured locally in the shop where they are to be used, but when such home-made jigs are not as effective time-savers as similar products on the market at a reasonable price, the latter should be purchased and allowed to earn dividends on their own cost and on the cost of expensive machines with which they are used.

Bolster Attachments for Metal Draft Arm

THE reinforcement of wood cars having weak draft sill and center construction has received much attention during the past few years. One of the most common methods of reinforcement is by the application of some form of metal draft arm. The application of such arms, of either structural or cast steel construction, in many cases makes practicable the retention in service of classes of equipment which otherwise would be too weak to withstand successfully the severe shocks of modern operating conditions.

In developing a program of reinforcement to these old wooden cars it may frequently occur that several classes of equipment with varying dimensions may be involved. In order that a minimum number of separate draft arm designs may be developed to meet the requirements of all classes of equipment involved in a given program and to provide a thoroughly satisfactory means of attachment of the draft arms to the bolsters, a scheme for the use of filler blocks and shims to compensate for the variations in the dimensions and location of the bolsters, without requiring a change in the draft arm itself, has been developed and patented by R. C. Taft, Moline, Ill. In all ordinary cases the scheme presupposes two designs of draft arms, one for all classes of high cars where the bolster passes under the center sill and another for all classes of low cars where the line of draft is between the center sills with a few possible exceptions. The proportions of these draft arms may be worked out on the basis of a composite diagram showing the location of the body bolster with respect to the end sill and its width and depth, for each class. The openings of the recesses in the draft arms are then designed to suit the maximum dimensions of the composite diagram.

In order that the draft arms thus standardized may be attached rigidly to the bolster in each case, filler blocks or shims, or a combination of the two, are designed for insertion between the bolster and the faces of the recess in the draft arm so that an unbroken metal path is provided between the draft arm and bolster for the transmission of buffing and pulling stress.

A typical application of cast spacing blocks in connection with a cast steel draft arm is shown in Fig. 1. Here it will be seen that the blocks are cast to fit the contour of the channels between the flanges and web of the H-section cast steel bolster, and that the forward spacing block is provided with a horizontal flange which is riveted to the bottom flange of

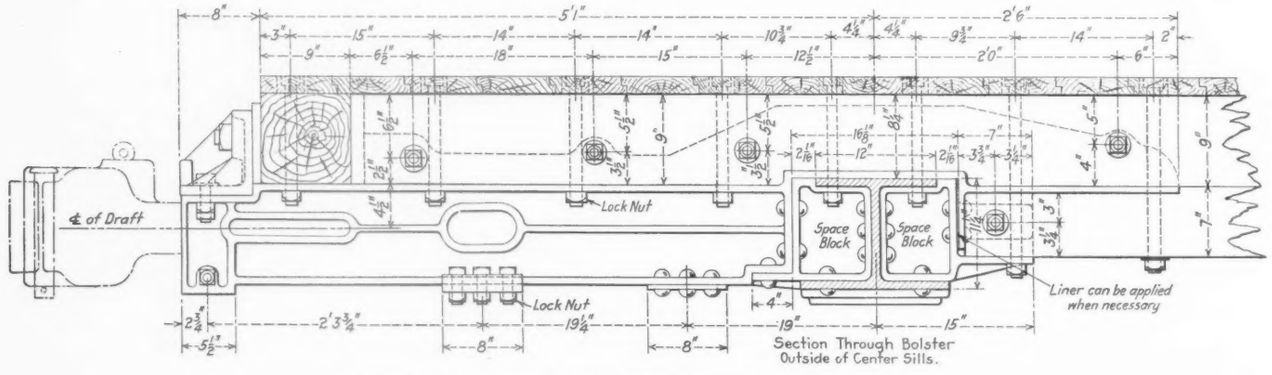


Fig. 1—Application of Spacing Blocks to a Cast Steel Draft Arm

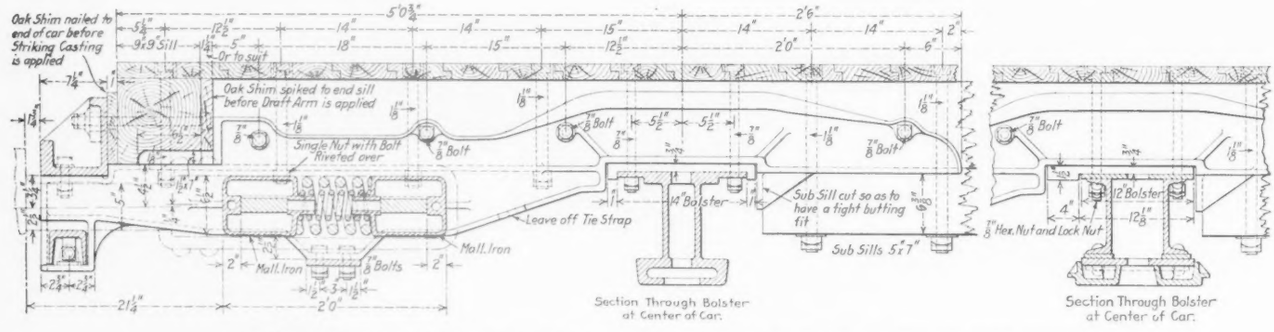

Oak Shim nailed to end of car before Striking Casting is applied
Oak Shim spiked to end sill before Draft Arm is applied
Single Nut with Bolt Riveted over
Leave off Tie Strap
Mall. Iron
Sub Sill cut so as to have a tight butting fit
Sub Sills 5"x7"
14" Bolster
12" Bolster
Hex. Nut and Lock Nut
Section Through Bolster at Center of Car.
Section Through Bolster at Center of Car.

Fig. 2—Application of Shims With Cast Steel Draft Arms to Body Bolsters on High Cars

A typical application of cast spacing blocks in connection with a cast steel draft arm is shown in Fig. 1. Here it will be seen that the blocks are cast to fit the contour of the channels between the flanges and web of the H-section cast steel bolster, and that the forward spacing block is provided with a horizontal flange which is riveted to the bottom flange of

the draft arm. Similarly, the rear spacing blocks have horizontal flanges extending under the ends of the sub-sills, which are butted against the rear vertical flanges of the bolster pocket in the draft arm. It will readily be seen that by variations in the dimensions of these filler blocks the same draft arm may be applied to cars with considerable variations in the location and dimensions of the body bolster.

The method of using shims in the case of low cars, where the line of draft and the draft arm pass through instead of over the bolster, is shown in Fig. 3. These shims may be varied in dimensions as required to suit the relation of the bolster to the recesses in the draft arm.

Either the cast blocks or the shims may be utilized in the

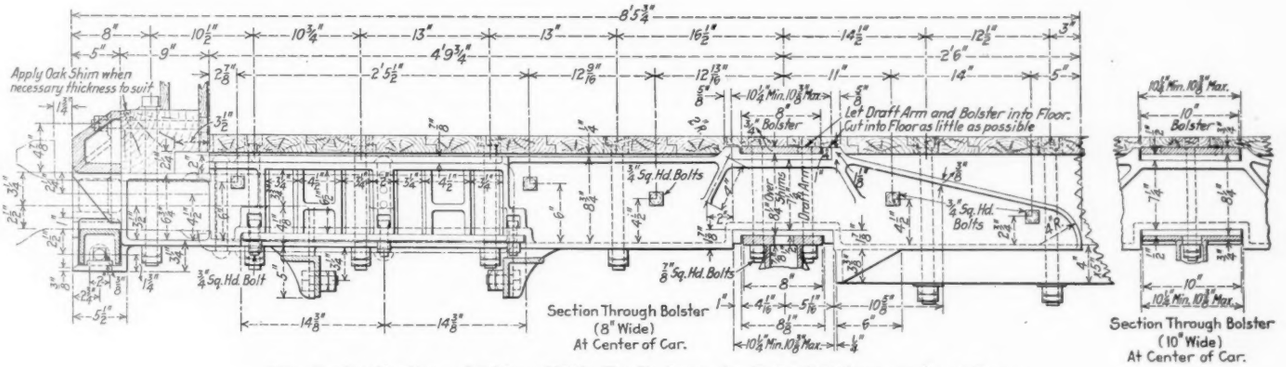
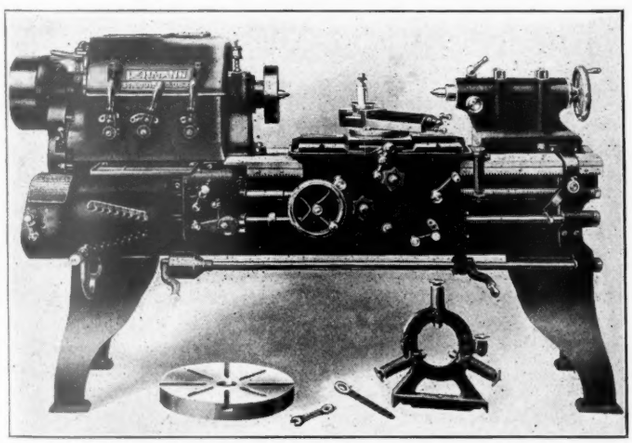

Apply Oak Shim when necessary thickness to suit
Let Draft Arm and Bolster into Floor. Cut into Floor as little as possible
Section Through Bolster (8" Wide) At Center of Car.
Section Through Bolster (10" Wide) At Center of Car.

Fig. 3—Application of Shims With Draft Arms to Body Bolsters on Low Cars

The use of shims instead of filler blocks on a similar application is illustrated in Fig. 2. This drawing clearly shows the method of adapting the draft arm to two sets of conditions. The flanges on the shims provide a complete metal-to-metal structure through the top or tension member of application of steel underframes to wood equipment. Their use has the same advantage of a standardized underframe design, a minimum of alteration in the car itself, and the solid anchoring of the bolsters in the underframe that obtains in the case of draft arm reinforcement.

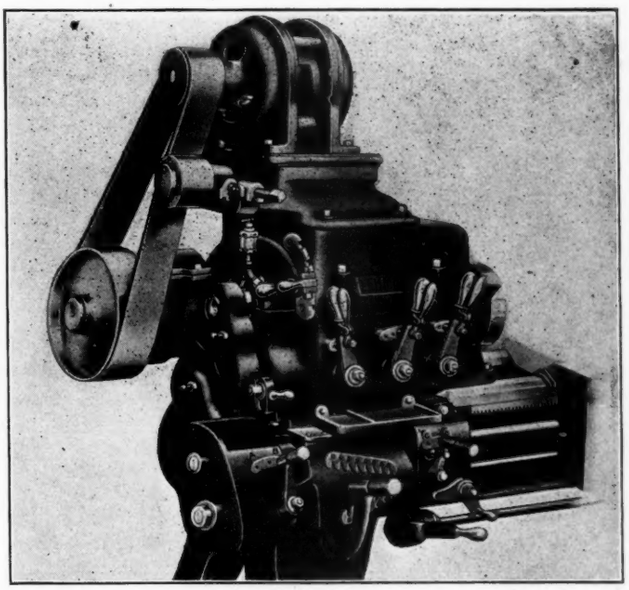
Compact Selective Head Engine Lathe

FOR toolroom work, especially where it is desirable to have a large number of speeds available, the improved, geared-head engine lathe manufactured by the Lehmann Machine Company, St. Louis, Mo., will be found well adapted. The lathe is built in a number of sizes and 16 spindle speeds are provided, ranging from 10.5 to 422 r.p.m. on the 16-in. lathe, and 8.5 to 330 r.p.m. on the 22-in. machine. These speeds are in almost exact geometrical proportion and are obtained without the use of a countershaft. Tooth travel of the 10 gears used in the head stock is moderate at all spindle speeds, which tends to make a quiet running machine. No safety or interlocking device is required to avoid engagement of different gear ratios at the same time, as the particular design makes it impossible for this accident to occur.



Lehmann Selective Geared Head Engine Lathe

Made of high carbon steel and running on ball bearings, all shafts with sliding members are provided with four keys milled integral with the shaft. Each shifting member is operated by a ring which runs in a groove completely encircling it, the compensating mechanism which connects the ring with the operating shaft being of substantial construction. Gear ratios of 57.1 to 1 and 70.6 to 1 are provided on the 16-in. and the 22-in. lathe respectively. This gear ratio permits the use of a high speed driving shaft and the large diameter driving pulley which gives a desirable belt speed and reduces the strain on belt and bearings. All part of



View Showing Application of Motor Drive

the head stock are designed to transmit power for the heavy cuts which can be taken on this machine.

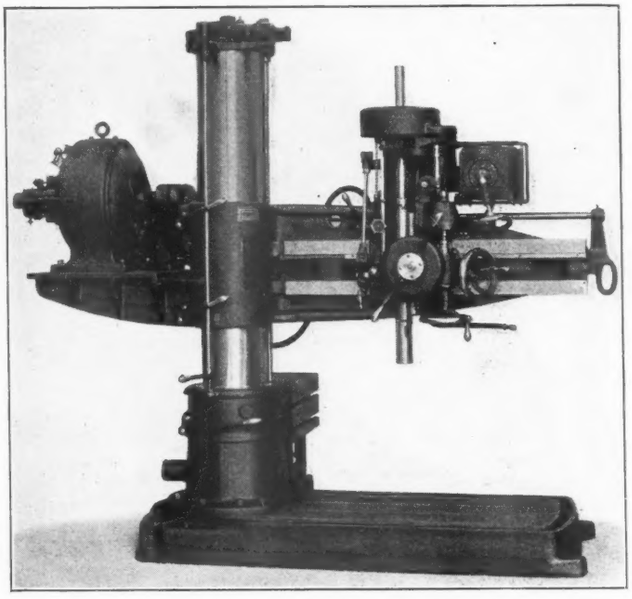
The most popular drive for Lehmann lathes is a direct drive from a motor mounted on the head stock. Power is transmitted through a short belt and idler running on ball bearings and having ample arrangements for adjustment. With the fast belt travel this is found to be a satisfactory drive and no trouble is experienced on account of the short belt. In fact, the belt pull is much less than usual on account of the large diameter and high speed of the driving pulley. A high speed motor operating at 1800 r.p.m. is used, with a suitable guard provided for the belt and pulleys. If desired, motor drive can be furnished with the motor mounted on a base hinged to the leg of the lathe.

New Drive for Heavy Duty Radial Drill

A RECENT development of the Fosdick Machine Tool Company, Cincinnati, Ohio, is the new type of motor drive furnished on the company's 4, 5 and 6-ft. heavy duty radial drills. The illustration shows the Fosdick 4-ft. heavy duty radial drill with a 5-hp., three to one variable speed motor, on the arm, and a Cutler-Hammer controller directly on the spindle head. The saving of power through the elimination of two sets of bevel gears is a big advantage; also the location of the motor away from dirt which accumulates about the floor. The swinging arm is partially balanced, and additional floor space about the base is available.

The outstanding feature of this particular application is the standardized drive; that is, three to one variable speed motors of any standard make or speed may be used, thus avoiding the customary delay caused by making special patterns and castings for each particular type of motor. A Bakelite pinion on the motor shaft varies in size according to the speeds of the motor as selected. All other gears (aside from the elimination of the bevel gears) are kept standard. Special stress is laid on the fact that but one motor is used. The elevating mechanism is driven from this same motor through the regular standard gear arrangement, whereby all the safety devices are retained.

The controller, as shown mounted on the spindle head, is made more convenient of operation by the bevel gear connection to the handwheel below it. This type of control is preferred in shops where the work is usually on large castings with the spindle head frequently at the upper and outer extreme travel. A more popular location for the controller is on the arm girdle, convenient to the operator's left hand.

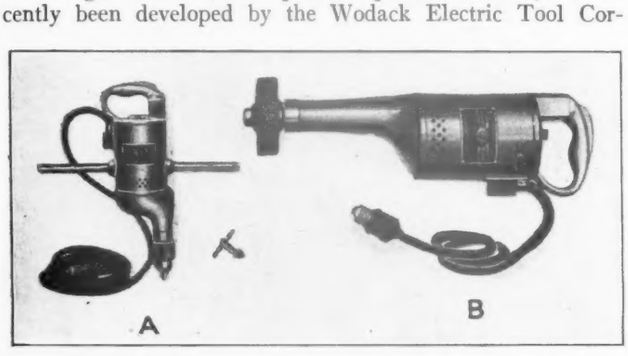


Fosdick 4-Ft. Heavy Duty Radial With New Motor Drive Arrangement

This eliminates the large flexible conduit as seen in the rear of the arm, and is the most satisfactory position for the average run of work.

Portable Electric Drill With Automatic Switch

A LINE of portable electric drills and grinders, in which automatic power control similar to that in general use on all portable pneumatic tools, has recently been developed by the Wodack Electric Tool Corporation, Chicago. The special feature of these tools is the switch, the operating member of which forms part of the hand grip, so arranged that the pressure of the operator's hand closes the switch and is required to maintain it in the closed position. With the release of the operator's hand from the grip, the switch automatically opens. The switch itself is designed as a complete unit separate from the drill case and is enclosed in the vertical support at the front end of the hand grip.



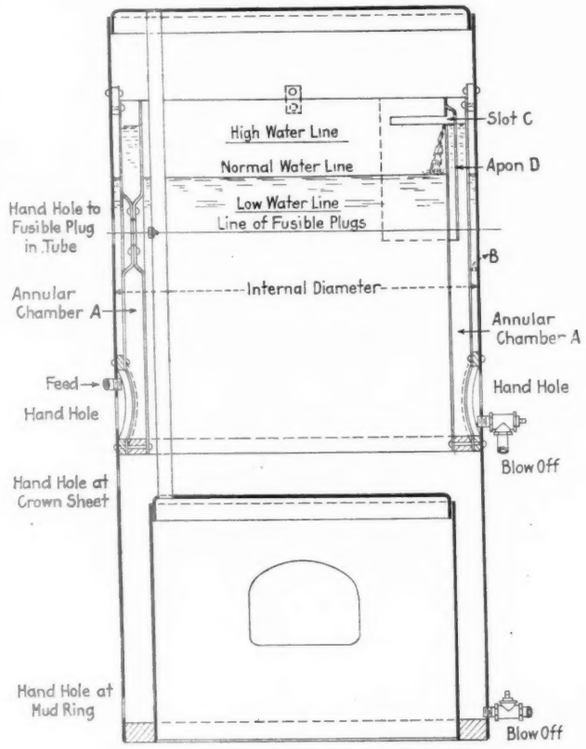
Wodack Portable Tools Equipped with Automatic Stop Feature

The motor and gear casing is of aluminum and a ventilating system is provided by which a positive flow of air is drawn into the casing, over the motor windings and forced out of the casing. In the design of these tools attention has been given to the elimination of screws, bolts and nuts to the fullest possible extent. In the design of the brush holder care has been taken to avoid the possibility for the accumulation of oil and grit and oiling is required only when the carbon brushes are changed. The gears and shaft are of chrome nickel steel and full ball bearings have been provided throughout.

The drills, one of which is shown at *A* in the illustration, are rated in six sizes ranging from 3/16-in. to ¾-in., and are said to deliver about 25 per cent more power than indicated by their ratings. The grinder, shown at *B*, is made in two sizes, one of which takes a wheel 3 in. by ½ in. by ½ in. and the other a wheel 4 in. by 1 in. by ⅞ in. The weight of the drills ranges from 5 lb. for the 3/16-in. size to 20 lb. for the ¾-in. size while the grinders weigh 5 lb. and 15 lb. respectively.

A Scale-Proof Locomotive Crane Boiler

FOR many users of locomotive cranes the largest single item of upkeep expense is the washing and maintenance work on the boiler. At best there is no ideal boiler feed water and locomotive cranes, working in sections remote from the central supply of purified boiler feed water, or on contract jobs where no purification plant is available, often are forced to use extremely poor water to feed into a boiler.



Parker Scale-Proof Locomotive Crane Boiler

The Industrial Works, Bay City, Mich., builders of the Industrial locomotive and wrecking cranes, are now building locomotive crane boilers equipped with an annular scale chamber placed between the tubes and the shell plate. The feed water is slowly passed through this scale chamber (at about 1/200 of the speed through the intake pipe) and attains a temperature at which the scale forming impurities will be liberated from solution without the use of any chemicals. The impurities are then carried in suspension and as the movement of the water is very slow these suspended precipitates settle down readily to the bottom of this chamber. This settling is accelerated by the decrease in density of the water as it is heated and by the decrease in its fluid friction.

The details of this design are fully indicated in the sectional view. The purifier consists of the annular scale chamber *A* extending completely around the tubes with a one-inch water space *B* between this chamber and the boiler shell. The outlet into the main portion of the boiler is the slot *C* guarded by the apron *D*. The feed water is admitted directly to the scale chamber *A* at a point farthest from the outlet slot.

It travels slowly around this chamber to the outlet and reaches approximately the boiler temperature before overflowing. The apron *D* keeps any floating impurities such as grease, oil, etc., from being discharged into the main boiler.

The sulphates of calcium are the hardest of the scale forming impurities to eliminate. They are precipitated at 280 deg. F., corresponding to the boiler temperature when holding the steam at only 35 lb. gage pressure. The carbonates and magnesia are precipitated at lower temperatures. These are all caught in the scale chamber together with mud, oil, and, in fact, all solids except common salt, for the first application of heat causes the liberation of these solids in the boiler over the crown sheet as well as in the scale chamber.

The scale forming impurities left in the scale chamber do not bake into scale as they do not come into contact with the hot furnace sheets, but they are left in the bottom of the scale chamber as soft mud, where they may be readily removed by blowing or washing out, quickly and easily, at the operator's convenience. It is stated that numerous tests have demonstrated the efficiency of this purifying device. In one test of a 42-in. diameter boiler of this type made at Paterson, N. J., a feed water naturally carrying 5 grains per gal. was loaded with 70 grains of calcium and 70 grains of earth, a total of 145 grains per gal. The feed water was taken from a barrel agitated with carbonic acid gas to form calcium carbonate. After about 1,200 gal. of this kind of water had been passed through the boiler, it was allowed to cool and the heating surfaces and lower mud ring were found to be perfectly clean and the mud was about six inches deep in the scale chamber. The blow-offs were both plugged so all impurities remained in the boiler. It was interesting to note that the presence of so much precipitated impurity in the scale chamber did not interfere with its operation.

This type of boiler was designed and patented in 1919 by Thomas T. Parker and has proved its value in utilizing all kinds of feedwater.

Redesigned Carbon Dioxide Recorders

COINCIDENT with the present acute interest in fuel economy and more efficient boiler operation, the Uehling Instrument Company, New York, has introduced a new model CO_2 recording equipment, known as style U, which embodies important improvements over the superseded model. Chief among its advantages are remarkably quick action, greater accessibility and simplicity of parts, and the economy of combining in one machine means for determining CO_2 simultaneously from any number of boilers, up to a total of six.

A single unit equipment for one boiler consists of three principal parts: namely, the CO_2 meter proper, recorder and auxiliary boiler front indicator. The meter is placed wherever is most convenient and its function is to actuate the boiler front indicator and recorder in the engineer's office. The flue gas is analyzed, that is, the CO_2 is extracted, in the meter and the principle involved in the operation depends upon the change in pressure caused by a change in volume in a stream of gas flowing through two apertures. In the new model the gas travel is hastened by utilizing the exhaust from the main aspirators in an auxiliary aspirator, while the main aspirator draws the gas sample through the absorption chamber. This prevents lag in the travel of gas from the boiler up to the absorption chamber.

With each unit is included a preliminary filter which removes soot and dirt from the sample before it reaches the intermediate and final filters on the machine. This has been redesigned so that the filter chamber can be conveniently

cleaned in a few seconds without interrupting operation of the machine.

Multiple equipments combine in a single outfit means for measuring CO_2 from two, three, four, five or six boilers independently and simultaneously. It is most economical to equip the boilers in batteries of six each, but this is not absolutely necessary, inasmuch as the CO_2 meters are now built on the unit plan and may be added to from time to time. With multiple unit machines, each boiler is equipped with its own recorder, auxiliary boiler front indicator, preliminary filter and absorbent chamber with necessary appurtenances, but the aspirator and other parts of the master unit serve all units in common.

The recorder operates on the hydrostatic principle, and thus all springs, levers and joint movements are avoided. It makes a continuous record of the per cent of CO_2, furnishing an autographic history of the operation of each boiler for every second of the day, showing when fires receive attention; when and how often furnace doors are opened, or how often stoker speed and fuel bed thickness are changed; fires broken and cleaned; effects of changes in damper regulation and methods of firing.

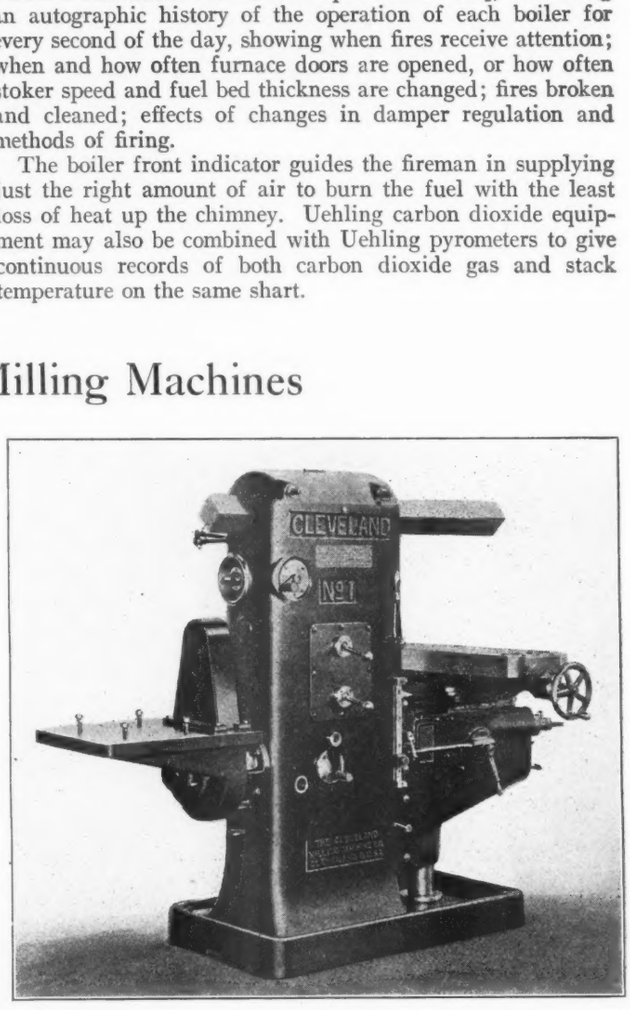
The boiler front indicator guides the fireman in supplying just the right amount of air to burn the fuel with the least loss of heat up the chimney. Uehling carbon dioxide equipment may also be combined with Uehling pyrometers to give continuous records of both carbon dioxide gas and stack temperature on the same shart.

Motor Drive for Milling Machines

ONE of the latest developments of the Clark-Mesker Company, Cleveland, Ohio, has been in applying mator drive to the Nos. 1 and 2 Cleveland milling machines. A friction clutch is provided in the drive between the sprockets and the chain, and the main drive shaft of the machine, which affords all the advantages of belt drive. The sprockets and chain run in oil and it is a simple matter to change over from the ordinary belt drive to electric motor drive by replacing the pulley housing with a bracket.

A constant speed motor is used running at about 1,200 r. p. m. The Morse chain used for the motor drive on the No. 1 machine is 2 in. wide and that on the No. 2 machine 2½ in. wide. The illustration shows that the motor is well up from the floor, away from dirt and chips, but not high enough to make the machine top heavy. An adjusting nut on the back of the motor drive housing is provided for adjusting the friction clutch for the main drive.

By this new development, all the advantages of individual electric motor drive are secured not only for users of new No. 1 and No. 2 Cleveland milling machines but for those already operating belt driven machines. The time and expense required for changing over will in many cases be far less important than the elimination of belt troubles and the more convenient placing of the machines.

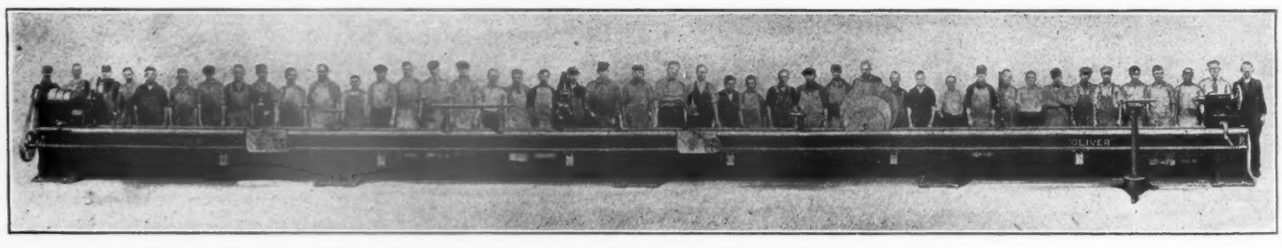


Milling Machine Arranged for Electric Motor Drive

Wood Turning Lathe of Unusual Length

THE wood turning lathe illustrated herewith was built in accordance with specifications written for the United States Government during the year 1919. The lathe was designed for the turning of spars or ship masts and has a swing of 32 in. and a bed 62 ft. long. Only two manufacturers were sufficiently interested to submit bids for the construction of this lathe, and the contract was finally awarded to the Oliver Machinery Company, Grand Rapids, Mich.

The bed of the lathe is cast in four sections, being supported upon five pedestals as indicated. Belt drive is secured from overhead shafting through four-step cone pulleys. Two power feeding carriages are provided; also several adjustable tool rests. In order to support the long and heavy work to be turned, two steady rests also are provided. The 44 men lined up in back of this machine, as shown in the illustration, were employed in its construction from the time of its design until it was shipped.

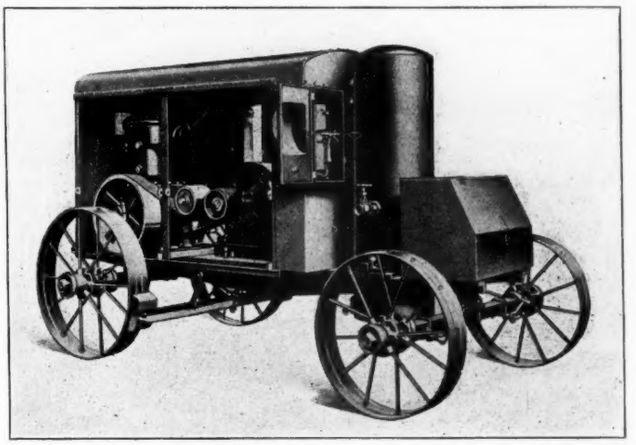


Oliver Wood Turning Lathe With 32-In. Swing and 62-Ft. Bed

Compact Portable Air Compressor Units

USERS of compressed air who are located at a distance from the central power stations must avail themselves of some type of portable air compressor. The Imperial portable compressor made by the Ingersoll-Rand Company, New York, is designed to meet the needs of this class of service. For gasolene power, these units are driven by tractor type gasolene motors and are built in three sizes, with capacities of 45, 118 and 210 cu. ft. per min. For use where electricity is available as motive power, an electric motor driven Imperial compressor has been designed. This unit is of 118 cu. ft. capacity and weighs approximately 4,450 lb., depending upon the weight of the motor. As in the case of the corresponding gasolene motor driven compressor, this electric unit is of all-steel construction. Light steel doors, easily removed, and a sheet steel canopy completely house the entire unit, protecting it from the weather and preventing undue deterioration from rust.

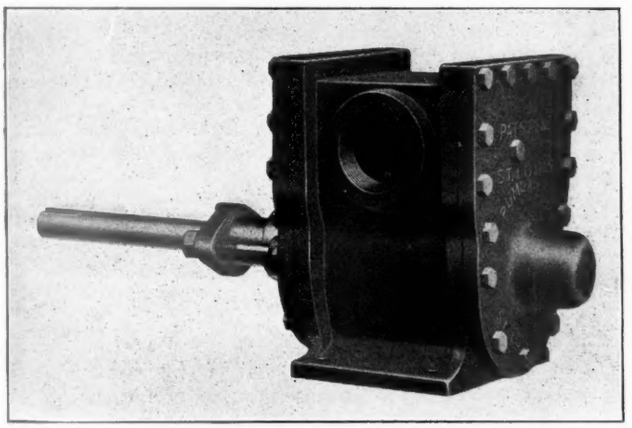
Either an alternating or a direct current motor can be furnished and a suitable intake unloader is provided, assuring efficient regulation. In any case, the motor control is in accordance with standard practice and specifications covering the type of motor used. Additional equipment includes an air receiver, safety valve, drain valves, pressure gage and service valves to which air hose lines may be connected.



Portable Air Compressor with Capacity of 118 Cu. Ft. per Min.

Efficient Rotary Piston Type Pump

IN the design of the rotary piston pump manufactured by the St. Louis Pump & Equipment Company, St. Louis, Mo., special attention has been given to the correction of weaknesses most common to pumping devices used for handling volatile and non-volatile liquids. The pump is simple,

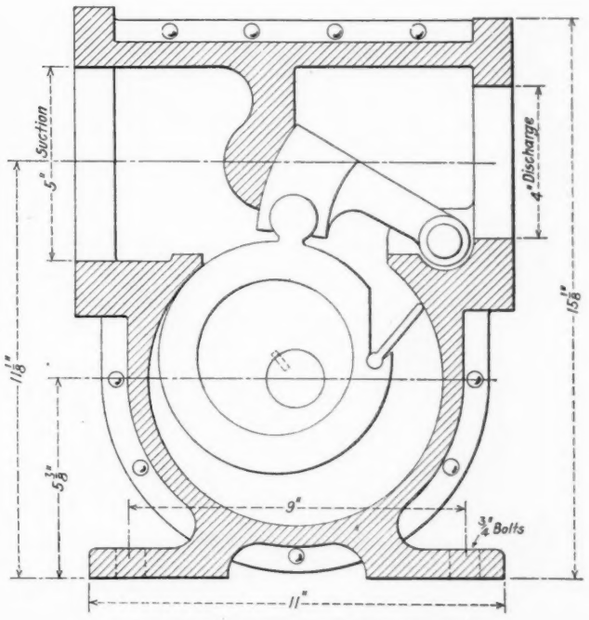


St. Louis Rotary Piston Type Pump

durable and stated to be unusually efficient; the best features of the rotary pump being combined with the best features of the piston pump.

There are only twelve major parts, consisting of a pump case with dividing partition, two end plates, a steel shaft with two eccentrics mounted thereon, two pistons, two rocker arms and two checks. Two chambers or cylinders are arranged, with a shaft passing through the center of each, two eccentrics, directly opposite in throw or 180 deg. apart, being mounted on the shaft. Surrounding these eccentrics and pivoted to the rocker arm are the two pump pistons. The arm serves to produce the reciprocating movement of the piston through the cam action of the eccentrics. Thus a composite reciprocating and rotary motion of the pump plunger or piston is obtained without actual contact of the piston and cylinder walls. The clearance, however, is small and a liquid seal results, giving vacuums up to 29 in.

The piston check is the only moving part touching the cylinder walls and this functions only at the point of transition at the end of the pumping suction movement or stroke to the beginning of a new stroke. The wear on this



Cross Section Showing Operating Parts

check is taken up automatically. The interval between the so-called strokes is so slight that an even impulse is imparted to the liquid handled. While the piston is discharging, it is acquiring fresh liquid on the opposite or suction side, and the piston in the opposite chamber is functioning conversely, thus giving balanced action.

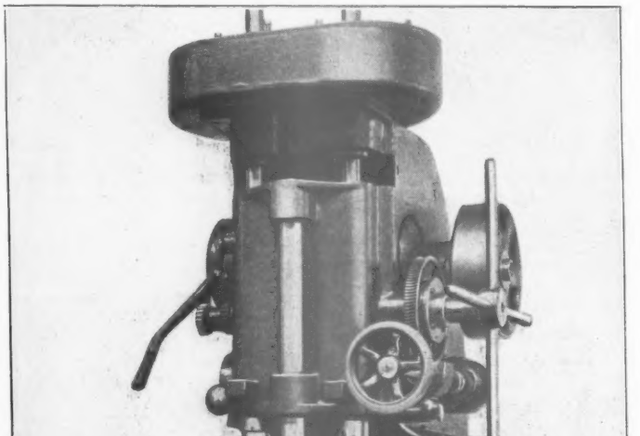
The construction is entirely of metal most suitable for the

liquids handled, so arranged that no two similar metals are in contact at any bearing point. All wearing parts on the pump are rotative and at every point at which wear may be encountered even to a minor degree, self-lubricated bearings capable of long service are used.

The head at one end of pump case is blind; that is, the shaft does not extend through and this eliminates packing. At the other end, a gland which holds the packing material, is bolted to the head. The pump is compact, light in weight, practically free from vibration, durable and self-lubricating when handling either volatile or non-volatile oils or similar liquids.

Baker Boring and Drilling Machine

A TWO-SPINDLE machine designed especially for work having successive operations such as drilling, reaming, boring, counterboring, turning and facing, has been placed on the market by Baker Brothers, Toledo, Ohio. It consists of two spindles feeding simultaneously to



Baker Two-Spindle Drilling Machine

work that is chucked on a circular indexing table. Three stations are provided so that the work is loaded and unloaded while the machine is in operation. Except for the very short indexing time, the machine is in constant operation and turning out work.

The spindles feed simultaneously but have independent speeds, thus driving each tool at its most efficient speed. Speed and feed changes are obtained by slip change gears, the drive being upon annular ball bearings. The principal specifications are: capacity, to drive 2-in. high speed drill; distance from center of spindle to face of column, 12¼ in.; distance from center of spindle to center of spindle, 10½ in.; length of feed, 12 in.

It seems probable that this machine would be adaptable to a variety of operations in railway machine shops, such as drilling and tapping nut blanks, drilling the many holes in brake hangers and rigging and many other similar operations.

Twenty-nine Passengers, 93 employees and six other persons were killed in train accidents during the second quarter of 1920 and 1,271 passengers, 690 employees and 23 other persons were injured; a total of 128 persons killed and 1,984 injured. Adding casualties in train service accidents—1,323 killed and 12,383 injured; and those in non-train accidents—112 killed and 25,398 injured—we have a total of 1,563 persons killed and 39,765 injured. The number of collisions reported in this quarter was 2,189 and of derailments 4,952. Adding miscellaneous accidents to trains we have a total of 7,883 accidents with total damage to cars and roadway of $7,762,500.

For the Good of Both the railways and the employees the thing most needed in the railroad field is an increase in the economy and efficiency of operation. The thing most needed to bring this about is an increase in the efficiency of labor. Probably nothing will contribute so much toward increasing the efficiency of labor as a better understanding by the managements and the men of one another's problems and points of view. The best way to bring about a better understanding will be for the officers and representatives of the employees of the various individual railways to get together and frankly talk over their mutual problems. Whether or not national agreements or national boards of adjustment exist under private operation, the efficiency and loyalty of the employees of the individual lines will depend largely upon the fairness and frankness with which the managements deal with them, and frequent conferences between the officers and representatives of the men can hardly fail to beget fairness and frankness on both sides.—*Railway Age.*

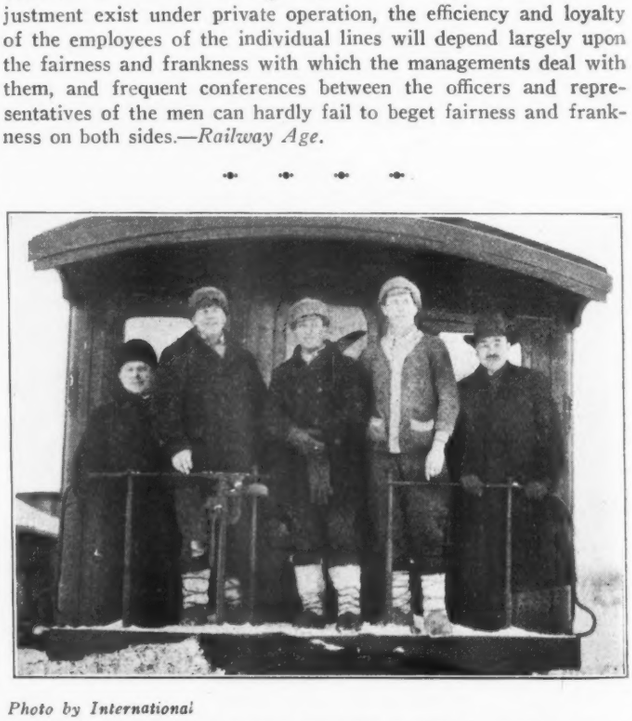


Photo by International

The Naval Balloonists, Who Were Lost in the Canadian Wilds, on Their Way Home

Railway Mechanical Engineer

(*Formerly the* RAILWAY AGE GAZETTE, MECHANICAL EDITION *with which the* AMERICAN ENGINEER *was incorporated*)

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WE GUARANTEE, that of this issue 10,300 copies were printed; that of these 10,300 copies 9,243 were mailed to regular paid subscribers, 9 were provided for counter and news company sales, 265 were mailed to advertisers, 32 were mailed to employees and correspondents, and 751 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 20,500, an average of 10,250 copies a week.

The *Railway Mechanical Engineer* is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

The directors of the American Railway Association, at a meeting in New York on January 6, elected Daniel Willard (B. & O.), chairman of the board and re-elected R. H. Aishton president of the association. W. G. Besler (C. of N. J.), was chosen first vice-president, in place of W. T. Tyler, and Hale Holden (C. B. & Q.), second vice-president, in place of E. H. Coapman. J. E. Fairbanks is general secretary and treasurer.

The total deficit for all the French railways for 1920 will be about $900,000,000, the operating ratio during the year being in the neighborhood of 125 per cent. The total number of employees has increased from 355,900 in January, 1914, to about 500,000; the amount of money paid out in wages meanwhile has increased 327 per cent. The greater part of the railways destroyed in northern France have been reconstructed and are now in operation.

The Chicago, Rock Island & Pacific has appointed a general reclamation committee, of which C. A. Morse, chief engineer, has been appointed chairman, and is conducting a campaign among its employees for the conservation of materials. The committee is not only urging employees to save on new materials, but also that all articles in need of repair be gathered up and shipped to the shops and that all scrap be moved as well. Under the direction of the committee the system has been placarded with posters advertising the drive.

The Chicago Safety Council recently organized a Steam Transportation Committee, which held its first meeting on December 21. At this meeting a general discussion took place as to the general activities which the committee would undertake. It was explained, however, that it was the intention that action should be taken as heretofore by individual roads regarding specific matters and an attempt be made to bring about the desired improvement or adjustment without referring matters to this committee for handling, except in special cases. C. L. Hinkle, general manager of the Chicago Great Western, is chairman of the committee, the personnel of which is representative of all the railroads in the city. Meetings of the committee are to be held once each month on the second Friday of the month at 12:30 p. m. in the Hotel Sherman, Chicago.

The pension list of the Philadelphia & Reading, established in 1902, now contains 485 names, of whom four have records of 57 years or more of service, and 72 others served 50 years or more. In the last issue of the "Roll of Honor," A. T. Dice, president of the road, expressed the management's appreciation of the long and faithful service these men had rendered. He said: "The prosperity which our company has enjoyed is due in no small part to your faithful service. Accordingly, it is just and right that you should share in that prosperity. You are entitled, also, in your retirement, to the satisfaction of knowing that by your work you have largely contributed to the upbuilding of the strong and important system of railroads we are now operating. The troublous times through which our country has passed since the beginning of the great war make clearer than ever before the value of efficient railroad service, and the vital interdependence of the country and the railroads."

Executive Committee Meeting of C. I. C. I. & C. F. Association

The Executive Committee of the Chief Interchange Car Inspectors' and Car Foremen's Association of America will meet at the Hotel Sherman, Chicago, on Thursday and Friday, March 3 and 4. The entire membership is invited to this meeting to suggest changes in the A. R. A. Rules of Interchange.

Engineering Council and A. S. M. E. to Meet in Syracuse

Herbert Hoover will be the principal speaker at a meeting in Syracuse, N. Y., on February 14, at which it is expected the plans of the American Engineering Council for dealing with industrial relations and, particularly, with the waste due to unemployment will be outlined. On the following day, February 15, the National Council of the American Society of Mechanical Engineers will meet.

Coal Production

The railways during 1920 transported the largest amount of bituminous coal ever handled by them in any calendar year except in 1918. The statistics of the United States Geological Survey regarding the amount of bituminous coal produced and transported up to December 18 of each of the last four years are as follows:

1917.....	536,288,000 tons	1919.....	441,592,000 tons
1918.....	566,349,000 tons	1920.....	537,555,000 tons

New Rolling Stock for New Zealand Railways

The government of New Zealand has signed a contract with the North British Locomotive Company for the delivery of 25 Pacific type locomotives at a price of $43,225 each. The weight of the locomotives will be 190,000 lb. in working order. Cammell Laird & Co. have received the contract for the delivery of 2,500 eight-ton freight cars at a price of $1,139.75 per car. In addition to the above, there are under construction in New Zealand, by Price Brothers, Thames, 20 locomotives of the Pacific type, similar in every respect to those to be supplied by the North British; also, ten of the same type to be built in the government's own workshops. The government is now calling for bids for 1,000 additional freight cars to be built in New Zealand.

The Pullman Company Wage Reduction

Conflicting reports resulting from an account of a so-called voluntary wage cut of 20 per cent by employees of the Pullman Company at Chicago, have simmered down to two or three authoritative outstanding facts.

In the first place, the suggestion of a wage cut was made by J. B. Weaver, vice-president in charge of construction of the Pullman Company, who advised the employees at the Pullman Car Works, which is an open shop employing 9,000 men, that a decrease in their pay was necessary. The matter of reductions in pay at the Pullman repair shop, which is unionized, has not yet been brought up.

At present, the company is restoring its men at the Pullman repair shop to the basis of a nine-hour day, as against the eight-hour day under which they have been working. The nine-hour day will apply five days a week, with a five-hour day on Saturday.

MEETINGS AND CONVENTIONS

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

American Railway Association, Division V—Mechanical—V. R. Hawthorne, 431 South Dearborn St., Chicago. Next convention June 15-22, Atlantic City, N. J. Exhibit by Railway Supply Manufacturers' Association.
Division V.—Equipment Painting Division.—V. R. Hawthorne, Chicago.

American Railway Association, Division VI.—Purchases and Stores.—J. P. Murphy, N. Y. C., Collinwood, Ohio. Second annual meeting June 20-22, Atlantic City, N. J.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—C. Borcherdt, 202 North Hamlin Ave., Chicago. Convention September 12, 13 and 14, Hotel Sherman, Chicago.

American Railway Tool Foremen's Association.—R. D. Fletcher, 1145 E. Marquette Road, Chicago.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

American Society for Steel Treating.—W. H. Eiseman, 4600 Prospect Ave., Cleveland, O.

Association of Railway Electrical Engineers—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago.

Canadian Railway Club.—W. A. Booth, 131 Charron St., Montreal, Que. Meeting second Tuesday in each month except June, July and August, at Windsor Hotel, Montreal, Que.

Car Foremen's Association of Chicago.—Aaron Kline, 626 N. Pine Ave., Chicago. Meeting second Monday in month, except June, July and August, New Morrison Hotel, Chicago.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, 604 Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis.

Central Railway Club.—H. D. Vought, 95 Liberty St., New York. Meeting second Thursday in January, March, May, September and November.

Chief Interchange Car Inspectors' and Car Foremen's Association.—W. P. Elliott, T. R. R. A. of St. Louis, East St. Louis, Ill. Next meeting March 3 and 4, 1921, Hotel Sherman, Chicago.

Cincinnati Railway Club.—W. C. Cooder, Union Central Building, Cincinnati, Ohio. Next meeting February 8. Short addresses will be made by E. R. Oliven, G. F. A., Southern Railway; A. G. Olberding, American Brake Shoe Company, and R. C. Barnard, superintendent, Pennsylvania System. There will also be a musical entertainment.

Dixie Air Brake Club.—E. F. O'Connor, 10 West Grace St., Richmond, Va.

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 715 Clarke Ave., Detroit, Mich. Next meeting, August 16, 17 and 18, 1921, Hotel Sherman, Chicago.

International Railway Fuel Association.—J. G. Crawford, 702 East Fifty-first St., Chicago. Next annual meeting, May, 1921, Hotel Sherman, Chicago.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn. Convention, September 12, 13, 14 and 15, 1921, Hotel Sherman, Chicago.

Master Boilermakers' Association.—Harry D. Vought, 95 Liberty St., New York. Convention, May 23 to 26, 1921, inclusive, Flanters' Hotel, St. Louis, Mo.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Next meeting February 8. Paper on Problem of Handling Material and Freight on Railroads will be presented by Charles N. Winter, Associate Editor, *Railway Mechanical Engineer*.

New York Railroad Club.—H. D. Vought, 95 Liberty St., New York. Next meeting, February 18. Paper on Operating Problems will be presented by J. J. Mantell, manager, New York Region, Erie Railroad.

Niagara Frontier Car Men's Association.—George A. J. Hochgrebe, 623 Brisbane Building, Buffalo, N. Y. Regular meetings, January, March, May, September and October.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal. Meetings second Thursday in month, alternately in San Francisco and Oakland, Cal.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Fa. Meetings fourth Thursday in month except June, July and August, Americus Club House, Pittsburgh.

St. Louis Railway Club.—B. W. Frauenthal, Union Station, St. Louis, Mo. Meetings second Friday in month except June, July and August.

Traveling Engineers' Association.—W. O. Thompson, N. Y. C. R. R., Buffalo, N. Y.

Western Railway Club.—Bruce V. Crandall, 14 E. Jackson Boulevard, Chicago. Next meeting, February 21. A paper on Modernizing Existing Locomotives will be presented by G. M. Basford.

PERSONAL MENTION

GENERAL

C. H. Temple, superintendent of motive power and car department of the Canadian Pacific, Western Lines, has been appointed chief of motive power and rolling stock, with headquarters at Montreal.

R, Preston, assistant superintendent of motive power of the Canadian Pacific, with headquarters at Winnipeg, Man., has been promoted to superintendent motive power and car department, Eastern Lines, with headquarters at Montreal.

W. L. Robinson, master mechanic of the Baltimore & Ohio, with headquarters at Washington, Ind., has been appointed superintendent fuel and locomotive performance, with headquarters at Baltimore Md., succeeding E. E. Ramey, who has been assigned to other duties.

H. H. Stephens, master mechanic of the Pecos division of the Atchison, Topeka & Santa Fe with headquarters at Clovis, N. M., has been promoted to mechanical superintendent of the Southern district with headquarters at Amarillo, Tex., succeeding W. D. Deveny, assigned to other duties. W. D. Hartley, general foreman, locomotive department, at Richmond, Cal., succeeds Mr. Stephens at Clovis.

R. A. Pyne, superintendent of the motive power and car department of the Canadian Pacific, Eastern Lines, with headquarters at Montreal, Que., has been transferred to Winnipeg, Man., succeeding C. H. Temple. A. Sturrock, master mechanic of the British Columbia district, with headquarters at Vancouver, B. C., has been promoted to assistant superintendent of motive power, with headquarters at Winnipeg, Man.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

J. W. Chandler has been appointed master mechanic of the Kansas City Southern, at Pittsburg, Kan., succeeding C. J. Burkholder, resigned to enter the service of another company. C. L Adair succeeds Mr. Chandler as master mechanic at Shreveport, La.

Edmund R. Woody, whose promotion to master mechanic on the Chesapeake & Ohio at Peru, Ind., was announced in the January issue, was born on September 10, 1880, at Richmond, Va. Mr. Woody entered the employ of the Chesapeake & Ohio on October 1, 1895, as a machinist apprentice and in 1900 was appointed erecting gang foreman. In 1909, he was transferred to the Newport News shops as assistant general foreman and in 1910 became general foreman at the Richmond Seventeenth street shops. In 1912 he was appointed assistant master mechanic in charge of the Fulton shops, Richmond, which position he held until his appointment as master mechanic at Peru.

E. R. Woody

Alexander Peers, who has been appointed master mechanic of the Canadian Pacific at Moose Jaw, Sask., Canada, was born in August, 1875, at Cheshire, England. Mr. Peers entered the service of the Canadian Pacific on July 16, 1901, at Winnipeg, as a machinist. From June 2, 1906, to June 12, 1906, he served as a draughtsman and from June 13, 1906, to August 6, 1906, served as relief locomotive foreman at Winnipeg, Fort William and Ignace. On August 7, 1906, he became locomotive foreman at

Souris, Brandon and Winnipeg. From April 24, 1914, until the time of his recent appointment, he was division master mechanic at Winnipeg and Moose Jaw.

G. M. LAWLER, who has been appointed master mechanic on the Atchison, Topeka & Santa Fe at La Junta, Colo., as noted in the January issue, was born on July 12, 1888, at Albuquerque, N. M. Mr. Lawler attended a business college for two years at night and entered the employ of the Atchison, Topeka & Santa Fe as a machinist apprentice at Albuquerque on February 28, 1905. In 1910 he was promoted to gang foreman and in 1911 became roundhouse foreman. In 1914 he was transferred to Belen, N. M., as division foreman and in 1916 was transferred to Raton, N. M., as general roundhouse foreman, which position he held at the time of his recent appointment.

G. M. Lawler

CAR DEPARTMENT

W. J. ROBIDER, general master car builder of the Canadian Pacific, has retired and the position has been abolished. The duties of general master car builder have been assumed by the assistant chief mechanical engineer.

SHOP AND ENGINEHOUSE

ERNEST RUICK, a machinist, has been promoted to night roundhouse foreman of the Atchison, Topeka & Santa Fe at Strong City, Kan.

R. TUCK, roundhouse foreman of the Atchison, Topeka & Santa Fe at Richmond, Cal., has been transferred to Needles, Cal., as general foreman. E. F. Callaher, formerly roundhouse foreman at Richmond and transferred to Needles, has been returned to Richmond.

E. A. MURRAY, master mechanic of the Chesapeake & Ohio, with headquarters at Clifton Forge, Va., has been promoted to shop superintendent at Huntington, W. Va., succeeding H. M. Brown, resigned. C. B. Hitch succeeds Mr. Murray as master mechanic at Clifton Forge.

JOHN EDWARD GARRETSON has been appointed general foreman on the Chesapeake & Ohio at Hinton, W. Va. Mr. Garretson was born on December 12, 1888, at Montgomery, W. Va. He attended the Hinton high school and in June, 1904, started to work as a call boy and a machinist's helper. In July, 1905, he entered the service of the Chesapeake & Ohio as a machinist apprentice at Hinton. After completing his apprenticeship, he worked as a machinist until 1912, when he was sent to Logan, W. Va. In May, 1914, he was promoted to day roundhouse foreman, and on December 1, 1916, became general foreman at Logan, which position he held until his recent appointment.

PURCHASING AND STOREKEEPING

EDMUND T. BURNETT has retired as general purchasing agent of the Norfolk & Western. Mr. Burnett was born in Philadelphia, Pa., and was educated at Saunders Institute. He was engaged in mercantile pursuits for several years after he had completed his schooling and first entered railway service in 1882 as chief clerk to the purchasing agent of the Norfolk & Western. In 1891 Mr. Burnett was appointed assistant purchasing agent, with headquarters at Roanoke, Va. In 1893 he was promoted to purchasing agent with headquarters at Philadelphia. When the road was reorganized in 1896 Mr. Burnett transferred his headquarters to Roanoke. When the government assumed the operation of the railroads Mr. Burnett was appointed, first, an associate member of the Eastern Regional Purchasing Committee and, later, regional purchasing agent for the Pocahontas region. When the roads were returned to their owners Mr. Burnett was appointed general purchasing agent of the Norfolk & Western.

SUPPLY TRADE NOTES

C. L. Mellor, manager of sales of the Barco Manufacturing Company, Chicago, has been elected secretary of this company. Mr. Mellor will continue his duties in charge of sales in addition to his duties as secretary.

John R. LeVally, formerly sales engineer of the Locomotive Superheater Company, at Chicago, has been appointed district sales manager of the company at Pittsburgh, Pa., with offices in the Union Arcade building.

Martin J. Root, formerly of the Fairbanks Company, New York, has been elected president of the United States High Speed Steel & Tool Corporation, which has been reorganized. The headquarters of the company are at 489 Fifth avenue, New York.

C. R. Weber has been elected treasurer of the Sherritt & Stoer Company, of Philadelphia, filling a vacancy made through the retirement of C. H. Stoer some time ago. Mr. Weber, previous to his appointment as treasurer, was in charge of the accounting department.

George S. Bigelow, formerly manager of the railway department of the Chicago Varnish Company, is now in charge of the railway department of the Mountain Varnish & Color Works, Inc., of Toledo, Ohio, with offices in the Railway Exchange building, Chicago.

Edmund H. Walker, first vice-president of the Standard Coupler Company, New York, has been elected president, succeeding George A. Post, who has retired. Mr. Walker has been connected with the company since February, 1905. Previous to his connection with the Standard Coupler Company he was engaged in railroad work with the Great Northern, the Atchison, Topeka & Santa Fe, the Chicago, Burlington & Quincy, and the Minneapolis, St. Paul & Sault Ste. Marie, in various departments. Mr. Walker has taken an active part in the work of the Railway Supply Manufacturers' Association and was three times elected president of the organization, serving in that capacity during the years 1917, 1918 and 1919.

E. H. Walker

C. E. Adams, vice-president of the Air Reduction Sales Company, New York, has been elected president to succeed A. F. Blagden, who has resigned to become associated with the American Dyewood Company, New York. John McHugh has been elected a director to succeed H. R. Hoyt, deceased.

The Hallidie Machinery Company, L. C. Smith building, Seattle, Wash., have been appointed representatives of the Conveyors Corporation of America, Chicago, formerly the American Steam Conveyor Corporation. They will handle the sales of the American steam conveyor and American trolley carrier in the states of Washington and Oregon.

The Whiting Foundry Equipment Company, Harvey, Ill., has announced that it has changed its name to the Whiting Corporation, increasing its authorized capital stock from $700,000 to $3,000,000. The Whiting Corporation remains under the same management and will continue the manufacture of cranes, foundry equipment and railway specialties as heretofore.

The Reade Manufacturing Company has moved from Hoboken, N. J., into its new factory at Jersey City, N. J., where additional facilities are available. Two new departments, a traffic depart-

ment and a mechanical or service department, have been added to the organization, both of which are under the supervision of R. H. Vogle, sales manager of the railroad department.

At the annual election of the Union Railway Equipment Company, Chicago, the following officers were elected: W. B. Hall, president and treasurer; G. W. Clark, controller and secretary; A. F. O'Connor, mechanical engineer; E. S. Jubell, superintendent; H. O. Comstock, sales agent. Mr. Jubell was formerly in charge of the forge department for the Haskell & Barker Car Company. The company's new forging plant, located on the Indiana Harbor Belt, at Hammond, Ind., is now in operation.

R. W. Levenhagen, secretary of the Sherwin-Williams Company, Cleveland, Ohio, has been elected vice-president in charge of auxiliaries of the Glidden Company, Cleveland. Mr. Levenhagen has spent the greater part of his life in the paint and varnish industry, having started with the Sherwin-Williams Company 25 years ago. He held various positions in the service of the Sherwin-Williams Company and rose steadily until he became secretary, which position he held until his recent election as vice-president of the Glidden Company. Besides serving as secretary of the Sherwin-Williams Company, he was vice-president and general manager of the Detroit White Lead Works, Detroit, Mich., and vice-president of the Martin-Senour Company, Chicago, for a number of years.

Joseph Sinkler has resigned his position with the Franklin Railway Supply Company, Inc., to become general manager of the railway division of the Pilot Packing Company, Inc., with headquarters in the Peoples Gas building, Chicago, Ill. Mr. Sinkler was born at Scranton, Pa., and began his business life with the Dickson Locomotive Works in the same city. Three years later he entered the employ of the New York, Susquehanna & Western and the Delaware, Lackawanna & Western. On July 1, 1904, he became associated with the Franklin Railway Supply Company, and on January 1, 1916, was appointed western representative of the Economy Devices Corporation, Chicago. Resigning from this position on November 15, 1917, he accepted a position as special representative of the Perolin Railway Service Company, and on January 1, 1919, returned to the services of the Franklin Railway Supply Company, where he remained until his present appointment.

J. Sinkler

Howard C. Mull, manager of the sales department of the Verona Tool Works, Pittsburgh, Pa., with headquarters at Chicago, has been appointed manager of the railway department of the Reliance Manufacturing Company, of Massillon, Ohio, with offices at Chicago. Mr. Mull was born on July 13, 1889, at Cincinnati, Ohio, and entered railway service in the engineering department of the Cleveland, Cincinnati, Chicago & St. Louis in 1910. Two years later he was transferred to Cleveland, Ohio, and placed in charge of safety matters. In May, 1913, he entered the employ of the Verona Tool Works, and two years later was promoted to representative of sales, western territory, with headquarters at Chicago. In 1918 he was appointed manager of sales, with headquarters at Chicago, the position he occupied at the time of his recent appointment.

On January 1 the Chambers Valve Company, Inc., New York, was taken over by the Bradford Draft Gear Company, with offices at 23 West Forty-third street, New York; Munsey building, Washington, D. C., and McCormick building, Chicago. Frank H. Clark, formerly president of the Chambers Valve Company, becomes vice-president of the Bradford Draft Gear Company, with headquarters at New York, while the Washington office will be under the direction of Harry F. Lowman, vice-president.

R. F. Eissler has been appointed assistant to the vice-president of the Chicago Pneumatic Tool Company, New York, with headquarters in the company's new office building at 6 East Forty-fourth street, New York. W. C. Straub, formerly district manager of the New Orleans branch, has been appointed district manager of the Pittsburgh branch to succeed Mr. Eissler, and Ross Wyeth, formerly attached to the Pittsburgh branch, has been appointed district manager of the New Orleans branch to succeed Mr. Straub.

A. D. Graves, manager trade sales of Pratt & Lambert, Inc., Buffalo, N. Y., has been appointed general manager of the company. This position was formerly held by President J. H. McNulty. C. D. Sproule, sales manager, western division, at Chicago, has been appointed resident manager with office at Chicago. J. R. Mickle, railway sales representative at New York, has been appointed sales manager at New York, and H. M. Guisey, assistant resident manager at Buffalo, has been appointed assistant sales manager at New York. The company held a convention from January 10 to 13 in a publicity building which it has recently completed in Buffalo, N. Y. At this meeting there were a number of interesting addresses made by officers of the company and many papers were presented by the salesmen.

A. D. Graves

Mr. Graves is a native of Ohio, his boyhood having been spent in Columbus. He was a bookkeeper in a wholesale drygoods house for nearly five years previous to entering the employ of a concern manufacturing varnish. In 1908, he started as a salesman for Pratt & Lambert and spent the next ten years in developing trade in Philadelphia and vicinity, when he became manager trade sales. Mr. Graves is one of the successful twelve Pratt & Lambert men whose high percentage of sales won them a trip to Europe in the summer of 1914.

Harry R. Warnock, vice-president in charge of mechanical matters of the Standard Stoker Company, New York, and formerly general superintendent of motive power on the Chicago, Milwaukee & St. Paul, died suddenly of heart failure at Hagerstown, Md., on January 19. He was born at Newcastle, Pa., on July 16, 1870. He began railway work as a freight brakeman with the Pennsylvania Lines West of Pittsburgh in June, 1889, and in the same year went to the Pittsburgh & Lake Erie as a brakeman. In September, 1891, he was promoted to locomotive fireman and later was locomotive engineer, which position he held until May, 1900. From that date until July, 1904, he served consecutively as engine despatcher, roundhouse foreman and general foreman, resigning on the latter date to become master mechanic of the West Side Belt, Pittsburgh, Pa., where he remained until October, 1905, when he became master mechanic of the Monongahela Railroad. He remained in this position until September, 1913, when he was appointed superintendent of motive power of the Western Maryland, which

H. R. Warnock

position he held until December 15, 1917, when he was appointed general superintendent of motive power of the Chicago, Milwaukee & St. Paul. In July, 1920, he became associated with the Standard Stoker Company and at the time of his death was vice-president in charge of mechanical matters, as above noted.

E. W. Englebright, who was engineer for the New York office of the Union Pacific until that office was merged recently with the organization of the assistant to the president at Omaha, Neb., where he has been located since that time, has resigned to become associated with the Elvin Mechanical Stoker Company, 50 Church street, New York. Mr. Englebright was born on January 12, 1885, at Oakland, Cal., and attended public schools until 1903. He then entered the employ of the Southern Pacific at Oakland, Cal., in its engineering department and served as rodman, levelman and transitman until 1905, when he entered the University of California, pursuing a course of civil engineer- until 1909. He then returned to the Southern Pacific and served as assistant engineer on the Shasta division at Dunsmuir, Cal., until 1910, when he was appointed assistant division engineer. In 1912 he served as roadmaster at Klamath Falls, Ore., remaining there until 1913, when he became assistant to E. E. Adams, then consulting engineer of the Union Pacific System for engineering, motive power and equipment standards, with headquarters at New York. Following the appointment, in 1918, of Mr. Adams as engineer for the Division of Capital Expenditures, at Washington, Mr. Englebright was appointed acting consulting engineer for the Union Pacific System corporations, with the added duties of purchasing the large number of locomotives and cars, orders for which were placed by the Union Pacific System prior to the termination of federal control. On the return of the railroads to private control he became engineer for the New York offices of the Union Pacific System, as noted above.

E. W. Englebright

Howard H. Marsh, for nearly eight years district manager of the *Railway Mechanical Engineer*, and the other publications of the Simmons-Boardman Publishing Company, at Cleveland, Ohio, has resigned to become president of the Victory Equipment Company, with office at 444 Maison Blanche Annex, New Orleans, La. As head of the Victory Equipment Company, he will handle the following accounts: McMyler-Interstate Company, Cleveland, locomotive cranes, pile drivers and material handling equipment; Ball Engine Company, Erie, Pa., steam shovels and railroad ditchers; Schaefer Equipment Company, Pittsburgh, Pa., truck lever connections, brake levers, brake rod jaws and stake pockets; and Equipment Manufacturing Company, Cleveland, trucks and trailers.

H. H. Marsh

His education, business experience and wide acquaintance fit Mr. Marsh for his new undertaking. He is still a young man, having graduated at the University of Vermont in 1903, with the degree of B.S. in civil engineering. That same year he entered the employ of Engineering News (now Engineering News-Record), as assistant to the western manager, and stayed there until 1907, when he was appointed western representative of Engineering-Contracting, with headquarters in Chicago. He left the latter place to go to Cleveland as district manager of the Simmons-Boardman Publishing Company. Mr. Marsh's removal to New Orleans is due to his desire to be near his family, as it was necessary for Mrs. Marsh to take up her residence in the Southwest in order that her health might be restored. In addition to his other work, Mr. Marsh will continue to act as representative of the Simmons-Boardman Publishing Company in the southwestern territory.

D. E. Sawyer has been re-elected general sales manager of the Pollak Steel Company, Cincinnati, Ohio, with office at 120 Broadway, New York; S. K. Morrow, manager of operations, has been appointed manager of sales for its three plants, with office at the Cincinnati works; C. G. Talbott, assistant manager of operations, has been appointed manager of rolled products for the Marion plant; A. C. Weihl, superintendent of the Cincinnati plant, has been appointed general works manager in charge of operations and productions of the Cincinnati, the Chicago and the Marion plants, and V. W. Prather, cost auditor for the Cincinnati plant, has been appointed auditor of the three plants. R. A. Mitchell has succeeded Mr. Weihl as superintendent of the Cincinnati plant; J. H. Deickman has been appointed manager of materials and inspection of its three plants; W. P. Woods has been appointed auditor, and G. H. Tallaksen, superintendent of the Chicago plant. The company has recently distributed a unique souvenir; it is a pen made in the form of a miniature standard M. C. B. car axle, with machined wheel seat and journal and rough turned center.

Lima Locomotive Works Changes

Lewis A. Larsen, assistant to the president of the Lima Locomotive Works, Inc., has been elected vice-president and Waldo H. Marshall has been elected a director.

L. A. Larsen

Mr. Marshall was formerly president of the American Locomotive Company and later resigned to go with J. P. Morgan & Co.

Mr. Larsen was born at Ridgeway, Ia., in 1875. He received his early education in the public schools of Ridgeway and Decorah, Ia., and Upper Iowa University, Northwestern University and St. Paul College of Law. In November, 1897, he entered the service of the Chicago Great Western as clerk to the master mechanic. He held successively the position of chief clerk to the superintendent of motive power and chief clerk to the assistant general manager. In 1904 he resigned to accept the position of chief clerk to the superintendent of motive power of the Northern Pacific at St. Paul. In November, 1906, he became associated with W. H. S. Wright, railway supplies, representing the Railway Steel Spring Company, the Pittsburgh Forge & Iron Company and other companies, and in 1907 entered the service of the American Locomotive Company. In 1909 he was appointed assistant to the vice-president in charge of manufacturing, and July, 1917, was appointed assistant controller. For several years previous to 1917 Mr. Larsen was a special lecturer in the Alexander Hamilton Institute, New York. He has also contributed a number of papers to the railroad magazines. In December, 1917, he was appointed assistant to the president of the Lima Locomotive Works.

Millholland Sales and Engineering Company

W. K. Millholland and E. Millholland have sold out one part of their interest in the Millholland Machine Company and have started a new company, called the Millholland Sales and Engineering Company, with temporary offices at 304 Rauh building, Indianapolis, Ind. After March 1 the company will occupy the machinery store which Marshall & Huschuert have been occupying. This new company will handle a line of railroad and machine shop equipment, and also foundry equipment, and act as consulting engineers on manufacturing and designing problems.

W. K. Millholland, for the past six years president and general manager of the W. K. Millholland Machine Company, previous to taking over active management of the Millholland company, was sales engineer for several large machine tool companies, and also designer for a machine tool company. He is a member of the American Society of Mechanical Engineers.

E. Millholland has for the past ten years been vice-president and works manager of the Millholland Machine Company. During the past three years he was also sales engineer.

The Foote-Burt Company Completes New Plant

The Foote-Burt Company, Cleveland, Ohio, has recently completed a new plant at East One Hundred and Thirty-first street and St. Clair avenue, which increases considerably the company's manufacturing facilities. The total floor area of the new shop is over 131,000 sq. ft. The main factory building is of brick, concrete and steel construction, 507 ft. by 236 ft., exclusive of the addition which houses the shipping department. Separate buildings are provided for the boiler house and for chip storage.

The equipment in the main building is arranged for progressive manufacturing. All material is received in the rear main aisle and is distributed from this aisle to the manufacturing department in the center of the building. The parts move to the front main aisle from which they are distributed to the assembling department in the front of the building. By means of a monorail system, the completed machines are taken from the assembling department to the shipping department. The general offices are on the ground floor across the front of the building, with the factory office on the west side, adjacent to the dispensary and experimental department. A notable feature of the plant is the drawing room, which covers the entire second story of the front end of the building and is approximately 235 ft. long by 24 ft. wide.

American Brake Shoe & Foundry Company

William F. Cutler, president of the Southern Wheel Company, St. Louis, Mo., has been elected vice-president of the American Brake Shoe & Foundry Company, with headquarters at New York, and William B. Given, Jr., assistant vice-president at New York, has also been elected a vice-president.

William F. Cutler was born on March 5, 1888, at Washington, D. C., and was educated at Hill School, Pottstown, Pa., and was in the class of 1909, at Sheffield Scientific School, Yale University. He began railway work as an apprentice in the Altoona (Pa.) shops of the Pennsylvania Railroad, and later served in the shops of the Hale & Kilburn Company, Philadelphia, Pa. In 1912 he entered the service of the American Brake Shoe & Foundry Company at New York, and subsequently held various positions until 1914, when he went to St. Louis as vice-president of the Southern Wheel Company, a subsidiary of the American Brake Shoe & Foundry Company. In 1917 he was elected president of the Southern Wheel Company, which position he still retains, in addition to his new position as vice-president of the American Brake Shoe & Foundry Company. He is a son of Otis H. Cutler, chairman of the board of the American Brake Shoe & Foundry Company.

William B. Given, Jr., was born on December 7, 1886, at Columbia, Pa., and was educated at Yale University. He has been in the service of the American Brake Shoe & Foundry Company since 1911, with the exception of two years, when he served in the United States Army. He held various positions with the American Brake Shoe & Foundry Company until 1915, when he was appointed assistant to president. From May, 1917, to May, 1919, he served as a captain of infantry in the Rainbow Division of the United States Army, and then returned to the American Brake Shoe & Foundry Company as assistant vice-president, which position he held until his recent election as vice-president of the same company as above noted.

TRADE PUBLICATIONS

Heaters.—The Ross Heater & Manufacturing Co., Inc., Buffalo, N. Y., has issued a 39-page book, Catalogue F, which illustrates and describes the various types of heaters, condensers, expansion joints, coolers and air-jector pumps which it manufactures.

Ladles.—The Whiting Corporation, Harvey, Ill., has issued catalogue No. 156 descriptive of their complete line of foundry ladles, including their new style helical worm geared crane ladle and a new style teapot spout ladle, having the spout inside of the bowl. The book is well illustrated.

Iron.—The Burden Iron Company at Troy, N. Y., have just issued a 30-page catalogue describing Burden iron products and their use in the railroad field. Clear cut illustrations show the various processes through which all Burden products must pass and particular attention has been given to various uses in locomotive and car construction. The booklet is well illustrated and very carefully written.

Riveting Machines.—Catalogue No. 4, entitled "Riveters," has been issued by the Hanna Engineering Works, Chicago, and includes 63 pages devoted to the description and illustration of various types of riveting machines. These machines include the common types of gap riveter, the boiler door ring riveter, pinch bug riveter, combination yoke riveter, forged nose riveter, boiler head riveter and others.

Radial Drills.—An unusually well illustrated and carefully prepared catalogue has been issued by the Western Machine Tool Works, Holland, Mich., devoted to a description of the Western low hung drive plain radial drill, designed for heavy duty. A general description and illustration of the machine is given in the front of the catalogue, accompanied by diagrams of the driving mechanism. A description also is included of a special tilting table.

The Melting Pot.—A monthly publication, known as The Melting Pot, containing much timely information regarding heat treatment, together with descriptions and illustrations of the use of Stewart furnaces, is being issued by the Chicago Flexible Shaft Company, Chicago. A large amount of information on annealing, carburizing and other heat treating subjects is included. In addition, there are many up-to-date and valuable notes on shop practice, particularly relating to heat treatment.

Screw and Ratchet Jacks.—The complete line of jacks made by the Duff Manufacturing Company, Pittsburgh, Pa., is described and illustrated in catalogue No. 104. Jacks of similar construction are grouped and a general description of the construction and operation is given, which is followed by a few short notes on the particular service for which each special type is best fitted. In the closing pages of the catalogue are shown illustrations of repair parts and tables to facilitate ordering material needed for repairs.

Vertical Surface Grinders.—A 40-page catalogue has been issued by the Blanchard Machine Company, Cambridge, Mass., containing in the foreword an interesting description of the development of the Blanchard vertical surface grinder. Illustrations are given showing the rigid construction and power of the machine. Special attention is called to the wheel mounting, spindle arrangement and direct motor drive; also the magnetic chuck. The reading pages of the catalogue are devoted to a description of the field for vertical surface grinding and the advantages of this method of machining are pointed out.

Lathe Chucks.—The 1921 catalogue of the Cushman Chuck Company, Hartford, Conn., is now ready for distribution and contains 50 pages, entirely rewritten and rearranged. Illustrations show the original Cushman workshop and the present plant. Each general style of chuck is fully described, and sizes and prices, together with code words, are quoted. Line drawings and tables also show the dimensions of detailed parts of the chuck. Useful information furnished in this catalogue includes directions for increasing the efficiency of lathe chucks, prolonging their life and instructions regarding the repair and replacement of parts.